5-3810-233-34

This copy is a reprint which includes current pages from Change 1.

TM 5-3810-233-34

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

TECHNICAL MANUAL

DIRECT SUPPORT AND GENERAL SUPPORT

MAINTENANCE MANUAL

CRANE, WHEEL MOUNTED, 5 TON

CAPACITY AT 10-FOOT RADIUS, 3/8 CU YD;

1 ENGINE, DIESEL DRIVEN, 4 x 4

(HANSON MACHINERY MODEL H446)

FSN 3810-948-0407

HEADQUARTERS, DEPARTMENT OF THE ARMY

AUGUST 1972

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Change No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, *19 September 1973*

Direct Support and General Support Maintenance Manual
CRANE, WHEEL MOUNTED; 5 TON CAPACITY AT 10-FOOT RADIUS; 3/8 CU. YD.; 1 ENGINE, DIESEL DRIVEN; 4 X 4; AIR TRANSPORTABLE (HANSON MACHINERY MODEL H446) FSN 3810-948-0407

TM 5-3810-233-34, 15 August 1972, is changed as follows:

The title is changed as shown above.

Pages 1-2 and 1-3. Hook block tie-down chain shown in figures 1-1 and 1-2 is no longer used.

Page 3-87. Paragraph 3-7*d.1* is added.

d.1. Test.

(1) Mount hydraulic pump on bench.

(a) Provide a 0.5 hp drive motor capable of driving the pump at 1200 rpm.

(b) Provide an oil reservoir of 3-to 4-gallon capacity.

(c) Install hose from pump inlet port to oil reservoir.

(d) Install hose from pump outlet port to tester inlet port.

(e) Install hose from tester outlet port to oil reservoir.

(f) Position reservoir so bottom of reservoir is level with or above pump inlet port, and fill with OE-10 engine oil.

(2) Drive pump at 1200 rpm and measure gpm at 150 ° F(66 ° C.) oil temperature.

NOTE

To heat oil, load to 1500 psi in 3-4 second cycles until required temperature is reached.

(a) Pump is rated 8 gpm at 1200 rpm and 100 psi.

(b) To compute gpm at differing rpm, multiply the rated gpm by actual rpm and divide by 1200.

(3) Volumetric efficiency should be 84 percent or greater. Compute efficiency by dividing actual gpm by rated gpm.

Page 4-23. Paragraph 4-19*e.1.* is added.

e.1. Test.

(1) Mount hydraulic pump on bench.

(a) Provide a 2.5 hp drive motor capable of driving the pump at 1200 rpm.

(b) Provide an oil reservoir of 20 gallons.

(c) Install hose from pump inlet port to oil reservoir.

(d) Install hose from pump outlet port (on shaft end) to tester inlet port.

(e) Install hose from pump outlet port (on cover end) to oil reservoir.

(f) Install hose from tester outlet port to oil reservoir.

(g) Position reservoir so bottom of reservoir is level with or above pump inlet port and fill with OE-10 engine oil.

(2) Drive pump at 1200 rpm and measure gpm at 100 psi with oil temperature of 150 ° F (66 ° C).

NOTE

To heat oil load to 1750 psi cycle load, every 3-4 seconds until required temperature is reached.

(a) Pump is flow control rated 10 gpm at 1200 rpm and 100 psi.

(b) To compute gpm at differing rpm, multiply the rated gpm by actual rpm and divide by 1200.

NOTE

Ensure that air is not induced by intake line leakage or turbulence in reservoir. Air in test system will adversely affect gpm readings.

(3) Repeat test (para (2) above) on cover end of pump.

(a) Install hose from pump outlet (cover end) to tester.

(b) Install hose from pump outlet (shaft end) to reservoir.

(c) Pump is flow control rated 10 gpm at 1200 rpm and 100 psi.

(4) Volumetric efficiency should be 84% or greater. Compute by dividing actual gpm by rated gpm.

Page 5-17. Paragraph 5-11*f* is added.

f. Removal, Installation, and Adjustment of Neutral Start Switch.

(1) *Removal.*

(a) Remove the two capscrews and cable control clevis pin securing the transmission shift tower.

(b) With the master switch in the OFF position disconnect the two wires leading to the neutral start switch.

(c) Remove the transmission shift tower.

(d) Remove the jam nut securing the neutral start switch to the transmission shift tower.

(2) *Installation and adjustment.*

(a) Place the transmission shift tower on a bench or work area where the relative position of the striker on the shift lever and the plunger of the neutral start switch can be viewed clearly.

(b) Place the transmission shift lever in neutral position.

(c) Locate the neutral start switch in position and back the adjusting nut off until there is clearance between the plunger head and the tip of the shift lever striker.

(d) Slowly advance the adjusting nut until a distinct "click" is heard.

CAUTION

Do not advance the plunger any further than is necessary to close the switch contacts as is evidenced by the "click" otherwise the switch may be broken when the lever is moved back and forth.

(e) Secure the switch with the jam nut.

(f) Connect one of the two wires previously disconnected to the NO (normally open) terminal of the switch and the other wire to the C (common) terminal.

(g) Reinstall shift tower.

By Order of the Secretary of the Army:

CREIGHTON W. ABRAMS
General, United States Army
Chief of Staff

Official:
VERNE L. BOWERS
Major General, United States Army
The Adjutant General

Distribution:
To be distributed in accordance with DA Form 12-25B, (qty rqr block No. 919) direct and general support maintenance requirements for Cranes, Wheel Mounted.

GPO 699-901

TECHNICAL MANUAL
No. 5-3810-233-34

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C. *15 August 1972*

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL
CRANE, WHEEL MOUNTED: 5 TON CAPACITY
AT 10 FOOT RADIUS; 3/8 CU YD;
1 ENGINE DIESEL DRIVEN 4 x 4,
(HANSON MACHINERY MODEL H446)
FSN 3810-948-0407

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual is for your use in operating and maintaining the Hanson Model H446 Wheel Mounted, Rough Terrain Crane as allocated by the Maintenance Allocation Chart contained in TM 5-3810-233-12. It provides information on the maintenance of the equipment which is beyond the scope of the tools, equipment, personnel, or supplies normally available to operational and organizational maintenance.

1-2. Maintenance Forms and Records

Maintenance forms and records that you are required to use are explained in TM 38-750.

1-3. Reporting of Errors

You can improve this manual by calling attention to errors and by recommending improvements, using DA Form 2028 or by a letter, and mail directly to the Commanding General, U.S. Army Mobility Equipment Command, ATTN: AMSME-MPP, 4300 Goodfellow Boulevard, St. Louis, Missouri 63120. A reply will be furnished directly to you.

1-4. Destruction of Army Materiel to Prevent Enemy Use

Refer to TM 740-244-3 for destruction procedures to prevent enemy use.

1-5. Administrative Storage

Refer to TM 740-90-1 for administrative storage.

Section II. DESCRIPTION AND DATA

1-6. Description

A general description of the Model H446 Rough Terrain Crane (fig. 1-1 and 1-2) and information pertaining to the identification plates are contained in TM 5-3810-233-12. The maintenance paragraphs of this manual contains detailed description of its components.

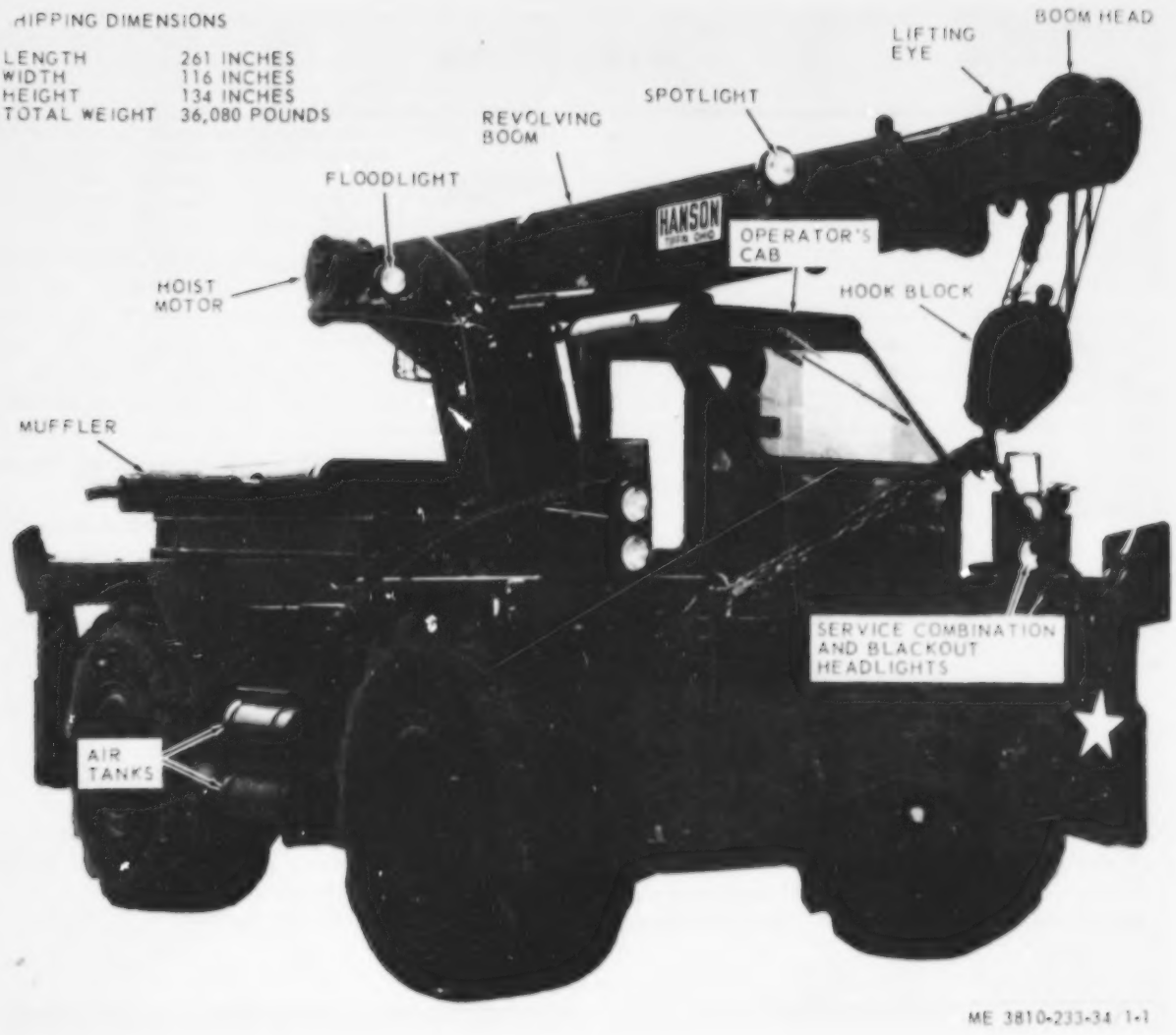


Figure 1-1. Crane, right front, three-quarter view, with shipping dimensions.

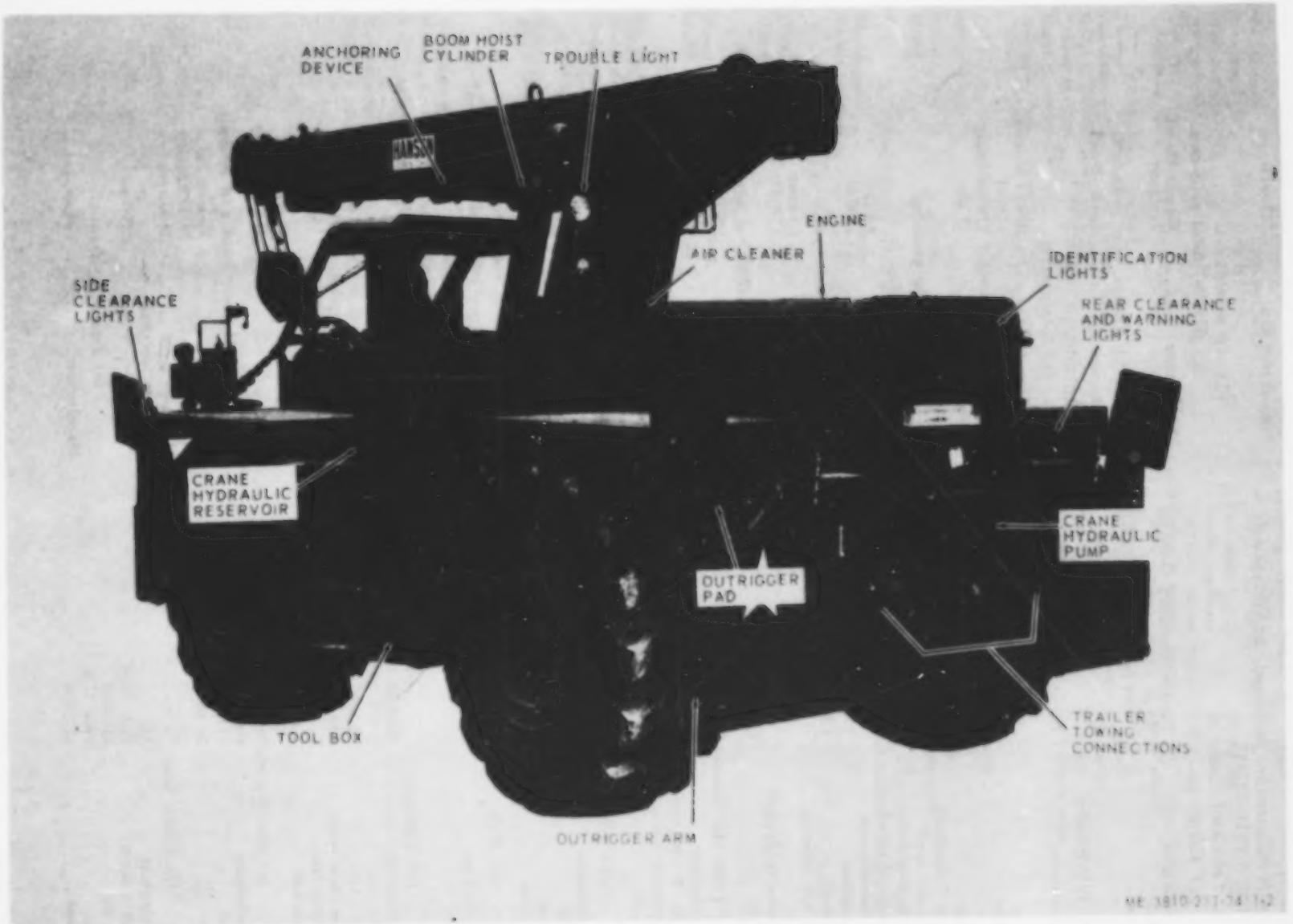


Figure 1-2. Crane, left rear, three-quarter view.

1-7. Tabulated Data

a. General. This paragraph contains maintenance data pertinent to direct and general support maintenance personnel. Additional data is in TM 5-3810-233-12.

b. Tabulated Data.

(1) *Crane.*

Manufacturer	Hanson Machinery Company
Model	H446
Type	Wheel mounted, 5 ton, DED rough terrain

(2) *Engine.*

Manufacturer	Detroit Diesel Engine Div., GMC
Type	Diesel
Model	3172
Bore	4.25 inches
Stroke	5 inches
Total displacement	213 cubic inches
Governed speed	2300 RPM @ full load
Horsepower rating	Intermittent service
Number of cylinders	3
Compression ratio (nominal)	17:1
Cooling	Liquid
Fan belt deflection	⅜ inch midway between pulley centers
Rotation (at flywheel end)	CCW

(a) Air cleaner (dry-type).

Manufacturer	Donaldson
Model (W/RBX00-2225) restriction indicator	SGB10-0160
Element	P10-1066

(b) Alternator, battery charging.

Manufacturer	Leece-Neville
Model	3002 series
Voltage	28 volt, 60 cycle
Amperage	60/40 ampere

(c) Relay, reverse polarity protection.

Manufacturer	Leece-Neville
Model	47393

(d) Batteries.

Manufacturer	Williard Storage Battery Co.
Type	6 TN, MS-35000-3
Volts	12 volts
Ampere-hour rating	100
Charging rate (nominal)	5 amperes for 24 hour period

(e) Starting motor.

Manufacturer	Delco Remy
Model	1113854
Volts	24 volts

(f) Filter, fuel.

Manufacturer	AC
Model (strainer)	Type T-60
Element	5574962
Model	Type T-58
Element	5573268

(g) Filter, lubricating oil.

Manufacturer	AC
Model	Type PM-13
Element (full flow)	5573014

(3) *Air system.*

(a) Brakes, front cylinders.

Manufacturer	Wagner Electric
Model	AC34393

(b) Brakes, rear cylinders.

Manufacturer	Bendix-Westinghouse
Model	Type 9

(c) Compressor.

Manufacturer	Bendix-Westinghouse
Model	276961
Pressure	120 psi (max)
Capacity	12 cfm

(4) *Hydraulic steering.*

(a) Cylinder, front.

Manufacturer	FWD
Model	199348

(b) Cylinder, rear.

Manufacturer	Garrison
Model	35-9-180-180

(c) Control valve, power steer, front.

Manufacturer	FWD
Model	114089

(d) Control valve, rear steer.

Manufacturer	Commercial Shearing & Stamping
Model	D-1310-1D-1

(e) Pump, hydraulic.

Manufacturer	Vickers, Inc.
Model	VTM27-60-50-15-F-07-R1-12

(5) *Steering, mechanical.*

Manufacturer	Ross Gear Division
Model	TE71062

(6) *Hydraulic system, crane.*

(a) Filters, hydraulic fluid, crane.

Manufacturer (external, return lines)	Gresen
Model (w/1570 spring)	FA-201-15
Element	1509
Manufacturer (sump filter, internal)	Dollinger
Model	H-1½-50 M33

(b) Motors, hoist and swing.

Manufacturer	Vickers, Inc.
Model	MMFB29U10
Maximum speed	2400 rpm
Maximum operating pressure	2000 psi

(c) Pump, hydraulic.

Manufacturer	Vickers, Inc.

Model	2520V17A1410C10002LH
Rated flow	10 gpm

(d) Cylinders, hydraulic.

Manufacturer	Hydranamics, Inc.
Boom hoist (2)	Dwg H1039-C
Boom extension (1)	Dwg H1038-C
Outrigger (4)	Dwg H1040-C
Rear axle, stabilizing (2)	Dwg H1080

(e) Valves, control.

Manufacturer	Vickers, Inc.
Model (5 section, hoist boom, etc.	CM11N02R25D1BDD21
Model (6 section), outrigger swing, accessory circuit	CM11N02R20DBDDDDE21

(7) Reversomatic transmission w/torque converter.

Manufacturer	Funk
Model	12000-Spec. 1865

(a) Filter, hydraulic oil.

Manufacturer	Funk
Model	12270

(b) Element

Model	5574540 (Type PF-141)
Manufacturer	AC

(8) Transfer case.

Manufacturer	FWD
Model	2621

(9) Axles, front and rear.

Manufacturer	FWD
Model (front)	108209
Model (rear)	108210

(10) Heater, cab, hot water.

Manufacturer	Hupp Corp.
Model	356

(11) Trouble light, pistol grip and reel type.

Manufacturer	Carpenter Mfg. Co.
Model	01-13435-AH

(12) Windshield wiper.

Manufacturer	American Bosch Arma Corp.
Model	WWC24K2633-121

(13) Starting aid.

Manufacturer	Turner Corp.
Model (cylinder only)	LP535

(14) Capacities.

Fuel tank	50 gallons
Engine crankcase	22 quarts
Hydraulic system, crane	128 quarts
Hydraulic system, power steer	2½ quarts
Reversomatic drive w/transmission	9 quarts
Coolant system	26 quarts
Transfer case	4 quarts
Differential case	11½ quarts each
Gear reduction case, hoist	1 quart
Gear reduction case, swing	3½ quarts
Cable, hoist, steel, 6 x 19 preformed	200 feet
Plantary gear box	2 quarts each

c. Torque Data. Tables 1-1, 1-2, and 1-3 list standard nut, bolt, stud and flared fittings torque data.

Table 1-1. Standard Nut and Bolt Torque Data

Size nut or bolt	Torque (ft—lb)
1/4-20	7-9
1/4-28	8-10
5/16-18	13-17
5/16-24	15-19
3/8-16	30-35
3/8-24	35-39
7/16-14	46-50
7/16-20	57-61
1/2-13	71-75
1/2-20	83-93
9/16-12	90-100
9/16-18	107-117
5/8-11	137-147
5/8-18	168-178
3/4-10	240-250
3/4-16	290-300
7/8-9	410-420
7/8-14	475-485
1-8	580-590
1-14	685-695

Table 1-2. Special Nut, Bolt, and Stud Torque Data

Application	Size	Torque (ft—lb)
End plate bolt	3 / 8-16	
Air box cover	3 / 8-16	10—15
Main bearing bolt (boring)	5 / 8-11	165—175
Main bearing bolt (assembly)	5 / 8-11	180—190
Cam follower guide bolt	1 / 4-20	12—15
Injector control shaft bracket bolt	1 / 4-20	10—12
Injector clamp bolt	3 / 8-16	20—25
Injector clamp nut	3 / 8-24	20—25
Fuel pipe nut	3 / 8-24	12—15
Lifter bracket bolt	7 / 16-14	55—60
Exhaust manifold nuts	7 / 16-20	30—35
Rocker shaft bolts	1 / 2-13	90—100
Cylinder head bolts	5 / 8-11	175—185
Cylinder head nuts	5 / 8-18	175—185
Injector clamp stud		10—25
Water manifold stud		10—25
Exhaust manifold stud		25—40
Exhaust Manifold outlet flange nuts	3 / 8-24	20—25
Water manifold nut	3 / 8-24	25—30
Oil pan bolts	5 / 16-18	10—12
Lifter bracket bolts	7 / 16-14	55—60
Main bearing nut (boring)	5 / 8-18	140—155
Main bearing nut (assembly)	5 / 8-18	155—185
Cylinder head stud	5 / 8-4"	175 min.
Balance weight cover bolt	3 / 8	25—30
Blower drive coupling to gear hub bolt	5 / 16-24	20—25
Camshaft intermediate bearing lockscrew	3 / 8-24	15—20
Accessory drive to gear bolt	3 / 8-24	45—50
Cam and balancer shaft nut	1-1 / 8-18	300—325
Balance weight to hub bolt	3 / 8-24	25—30
Blower drive gear hub nut	1-1 / 2-16	50—60
Crankshaft front cover	3 / 8-24	25—30
Connecting rod nut-castellated	7 / 16-20	65—75
Crank shaft front cover	1 / 2-13	80—90
Crankshaft end bolt	1-14	290—310
Flywheel bolts	9 / 16-18	150—160
Flywheel hsg bolts	3 / 8-16	25—30
Idler gear hub and spacer bolts	3 / 8-16	40—45
Flywheel hsg. bolts	1 / 2-13	90—100
Idler gear hub and spacer bolts	3 / 8-16	40—45
Cam and balancer shaft end bearing bolt	3 / 8-16	35—40
Tachometer drive cover bolts		30—35

Table 1-3. Torque Values for 37° Flares Fittings

O. D. Size	Tube Wall	Assembly Torque	Turns After Finger Tight
1 / 8 inch	.028 inch	70 in. lbs.	1 / 2 turn
3 / 16 inch	.028 inch	95 in. lbs.	1 / 2 turn
1 / 4 inch	.035 inch	250 in. lbs.	1 turn
5 / 16 inch	.035 inch	325 in. lbs.	1 turn
3 / 8 inch	.049 inch	450 in. lbs.	1 turn
1 / 2 inch	.049 inch	700 in. lbs.	3 / 4 turn
5 / 8 inch	.049 inch	800 in. lbs.	3 / 4 turn
3 / 4 inch	.049 inch	950 in. lbs.	1 / 2 turn
7 / 8 inch	.049 inch	1050 in. lbs.	3 / 4 turn
1 inch	.065 inch	1200 in. lbs.	3 / 4 turn

d. Repair, Replacement, and adjustment Standards. Table 1-4 lists the manufacturer's sizes, tolerances, and maximum wear and clearance's.

Table 1-4. Repair and Replacement Standards

Component	Manufacturer's dimensions and tolerances in inches		Maximum allowable wear and clearance
	Minimum	Maximum	
ENGINE			
Cylinder block:			
Block bore:			
Diameter	4.6265	4.6275	
Out-of-round		0.0010	0.0030
Taper		0.0010	0.0020
Cylinder sleeve counterbore:			
Diameter	5.0460	5.0485	
Depth	0.4785	0.4795	
Main bearing bore			
Inside diameter	3.8120	3.8130	
Top surface of cylinder block:			
Center line of crankshaft to top of cylinder block	16.1840	16.1890	16.1760 min.
Flatness-transverse			0.0030
Flatness-longitudinally			0.0060
Depth of counterbore (top)			
Cylinder head seal strip groove	0.0920	0.1070	
Large water holes (between cyl)	0.1090	0.1200	
Small water holes (at ends)	0.0870	0.0980	
Comb. water and oil holes	0.0870	0.0980	
Cylinder sleeves			
Outside diameter	4.6250	4.6260	
Clearance, sleeve-to-block bore	0.0005	0.0025	0.0030
Depth of sleeve, flange below block	0.0465	0.0500	0.0500
Variation in height between adjacent liners		0.0020	0.0020
Cylinder head			
Flatness-			
Transverse			0.0040
Longitudinally			0.0055
Distance between top deck and fire deck	3.5560	3.5680	3.5360
Water nozzles	1 / 32 recessed	Flush	
Cam follower bores			
Exhaust valve seat inserts			
Seat width (30°)	1 / 16	3 / 32	3 / 32
Valve seat runout		0.0020	0.0020
Exhaust valves			
Stem diameter	0.3417	0.3425	0.3405
Valve head to cylinder head	0.0230 recessed	0.0060 protrusion	
Valve guides			
Height above cylinder head	1.530	1.530	
Diameter-inside	0.3445	0.3455	0.3465
Clearance-stem to guide	0.0020	0.0038	0.0060
Rocker arms and shafts			
Rocker shaft diameter	0.8735	0.8740	
Rocker arm shaft bushing-inside diameter	0.8750	0.8760	
Clearance-shaft to bushing	0.0010	0.0025	0.0040
Cam followers			
Diameter	1.0600	1.0610	
Clearance-follower to head	0.0010	0.0030	0.0060
Cam follower rollers and pins			
Clearance-pin to bushing	0.0013	0.0021	0.0100 (horiz.)
Side clearance-roller in follower	0.0150	0.0230	0.0230
Crankshaft			
Journal diameter-main bearing	3.4990	3.5000	
Journal diameter-conn. rod	2.7490	2.7500	
Journal out-of-round		0.00025	0.0010
Journal taper		0.0005	0.0015
Runout on journals- total Indicator reading (mounted on No. 1 and No. 4 journals) At No. 2 and No. 3 journals		0.0020*	

* Tolerance given for guidance when regrinding crankshaft.

Table 1-4. Repair and Replacement Standards (Continued)

Component	Manufacturer's dimensions and tolerances in inches		Maximum allowable wear and clearance
	Minimum	Maximum	
Thrust washer-thickness	0.1205	0.1220	
End thrust clearance (end play)	0.0040	0.0110	0.0180
Main bearings			
Bearing inside dia. (vertical axis)	3.5014	3.5034	
Clearance-bearing to journal	0.0014	0.0044	0.0060
Bearing thickness- 90° from parting line	0.1548	0.1553	0.1530 (min.)
Connecting rod bearings			
Inside diameter (vertical axis)	2.7514	2.7534	
Clearance-bearing to crankshaft journal	0.0014	0.0044	0.0060
Bearing thickness-90° from parting line	0.1548	0.1553	0.1530 (min.)
Pistons and rings			
Piston-			
Height-centerline of bearing to top of piston	3.5130	3.5180	
Diameter:			
At top	4.2190	4.2220	
At skirt-below compression ring grooves to bottom	4.2433	4.2455	
Clearance-piston skirt to liner	0.0040	0.0078	0.0120
Out of round		0.0005	
Taper		0.0005	
Compression rings-Gap	0.0180	0.0430	0.0600
Clearance- ring to groove	0.0095	0.0310	0.0220
Top ring	0.0075	0.0110	0.0150
No. 2	0.0055	0.0090	0.0130
No. 3 and 4			
Oil control rings-	0.0080	0.0230	0.0430
Gap	0.0015	0.0055	0.0080
Clearance-ring to groove			
Piston pin bushing •			
diameter-	1.5025	1.5030	1.5050
Inside	1.7540	1.7555	
Outside			
Piston Pin-	1.4996	1.5000	1.4980
Diameter			
Clearance-pin to piston	0.0025	0.0034	0.0100
bushing	0.0015	0.0024	0.0100
Clearance-pin to rod bushing	3.6050	3.6200	
Length			
Camshaft			
Shaft diameter at bearings:	1.4970	1.4975	
Front and rear	1.4980	1.4985	
Center and intermediate	1.1875	1.1880	
Shaft diameter at gear			
Length-thrust bearing end journal	2.8740	2.8760	
	0.0040	0.0110	0.0180
End thrust	0.1200	0.1220	
Thrust washer thickness			
Balance shaft			
Shaft diameter at bearings	1.4970	1.4975	
Shaft diameter at gear	1.1875	1.1880	
Length-thrust bearing end journal	2.8740	2.8760	
	0.0040	0.0120	0.0180
End thrust	0.1200	0.1220	
Thrust washer thickness			
Camshaft and balancer shaft bearings			
Inside diameter:	1.5000	1.5010	
Front and rear	1.5010	1.5030	
Center and intermediate			
Clearance, bearings-to-shaft:	0.0025	0.0040	0.0060
Front and rear	0.0025	0.0050	0.0090
Center and intermediate			

Table 1-4. Repair and Replacement Standards (Continued)

Component	Manufacturer's dimensions and tolerances in inches		Maximum allowable wear and clearance
	Minimum	Maximum	
Outside diameter of bearings:	2.1880	2.1885	
Front and rear	2.1840	2.1860	
Intermediate	2.1875	2.1885	
Diameter of block bore			
Clearance, bearings-to-block:	0.0010	0.0050	
Front and rear	(press)	(loose)	
Intermediate	0.0015	0.0045	
Camshaft and balance shaft gears			
Backlash	0.0030	0.0080	0.010
Gear inside diameter	1.1865	1.1875	
Clearance-gear to shaft	0.0015	0.0000	
	(press)		
Idler gear			
Backlash	0.0030	0.0080	0.010
Crankshaft timing gear			
Backlash	0.0030	0.0080	0.010
Gear inside diameter	4.7490	4.7500	
Clearance-gear to crankshaft	0.0010	0.0010	
	(press)	(loose)	
Blower drive gear			
Backlash	0.0030	0.0080	0.010
Gear to hub fit	0.0005	0.0010	
	(press)	(loose)	
Support to end plate	0.0005	0.0025	
	(press)	(loose)	
Support bushing-inside dia.	1.6260	1.6265	
Hub diameter-at bushing	1.6240	1.6250	
Hub to support bushing clearance	0.0010	0.0025	0.0050
Hub to cam clearance	0.0020	0.0070	
End thrust	0.0050	0.0080	0.0100

NOTE

Recommended maximum allowable wear and clearance specified below are generally applicable to other major components of the crane unless exception is noted in the text dealing with the respective assembly.

Total radial clearance:

Bearings	0.0025
Bushings	0.0035
Endplay-shafts	0.0250

e. Schematic Wiring Diagrams. Figures 1-3, 1-4, and 1-5 show the schematic wiring diagrams for the Hanson Model H446 Rough terrain crane.

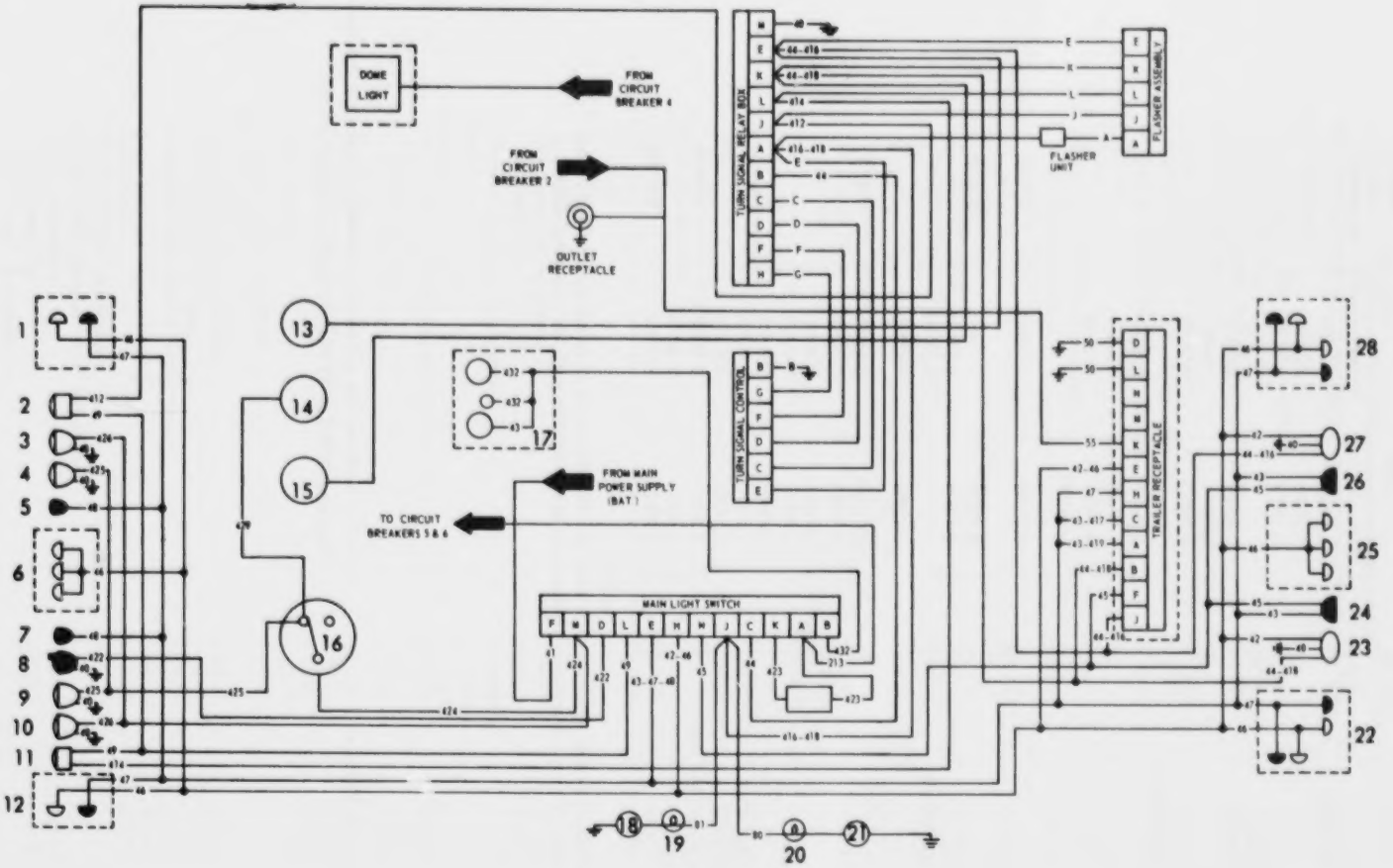


Figure 1-3. Wiring diagram, carrier lighting.

Key to figure 1-3:

1 Blackout service sidemarker clearance lights
2 Right front service combination light
3 Low-beam headlight
4 High-beam headlight
5 Blackout marker light
6 Service identification lights
7 Blackout marker light
8 Blackout headlight
9 High-beam headlight
10 Low-beam headlight
11 Left front service combination light
12 Blackout service sidemarker clearance lights
13 Right turn indicator light
14 High-beam indicator light
15 Left turn indicator light
16 Headlight dimmer switch
17 Panel illumination lights
18 Rear steer lever switch
19 Rear steer lock indicator light
20 Differential lock indicator light
21 Differential lock lever switch
22 Blackout service sidemarker clearance lights
23 Left rear combination service light
24 Left rear blackout combination light
25 Service identification lights
26 Right rear blackout combination light
27 Right rear service combination light
28 Blackout service sidemarker clearance lights

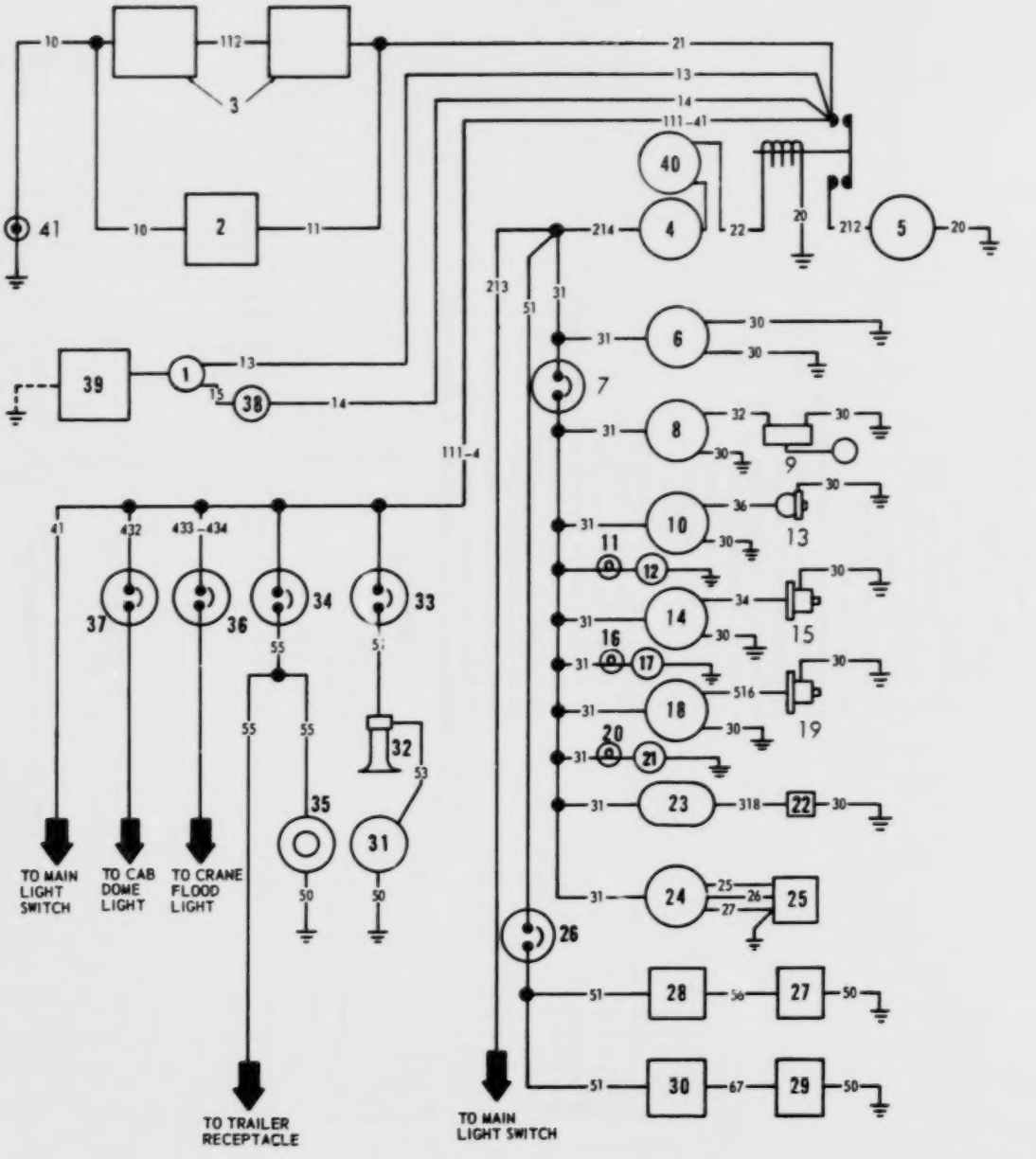


Figure 1-4. Wiring diagram, carrier power and monitor circuits.

Key to figure 1-4:

1 Reverse plarity relay
2 Slave receptacle
3 Storage batteries
4 Starter switch
5 Starter motor
6 Battery-generator indicator
7 Circuit breaker (CB-5)
8 Fuel gage
9 Fuel gage sending unit
10 Oil pressure gage
11 Low oil pressure warning light
12 Low oil pressure warning switch
13 Oil pressure sending unit
14 Engine coolant temperature gage
15 Engine coolant sending unit
16 High coolant temperature warning light
17 Coolant temperature warning light switch
18 Transmission oil temperature gage
19 Transmission oil temperature sending unit
20 Transmission oil temperature warning light
21 Transmission oil temperature warning light switch
22 Low air pressure buzzer
23 Low air pressure switch
24 Tachometer
25 Tachometer sending unit
26 Circuit breaker (CB-6)
27 Cab heater motor
28 Cab heater motor switch
29 Windshield wiper motor
30 Windshield wiper motor switch
31 Air horn switch
32 Air horn solenoid
33 Circuit breaker (CB-1)
34 Circuit breaker (CB-2)
35 Instrument panel outlet receptacle
36 Circuit breaker (CB-3)
37 Circuit breaker (CB-4)
38 Fuel pressure switch
39 Alternator
40 Neutral switch
41 Frame bolt

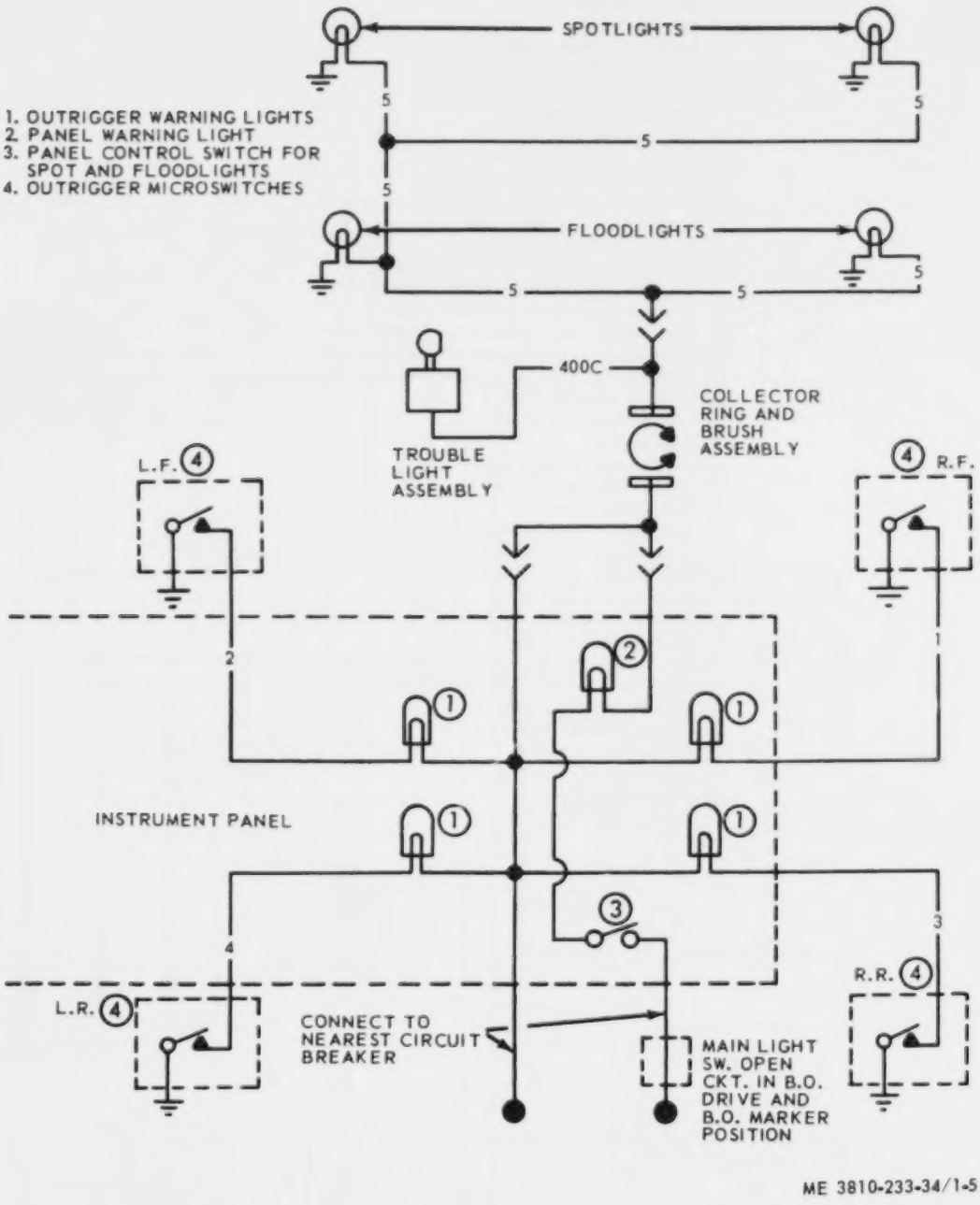


Figure 1-5. Wiring diagram, crane lighting, and outrigger monitor circuits.

f. Crane Hydraulic System Diagram. Figure 1-6 shows the schematic diagram for the crane hydraulic system, including the front power steering supply.

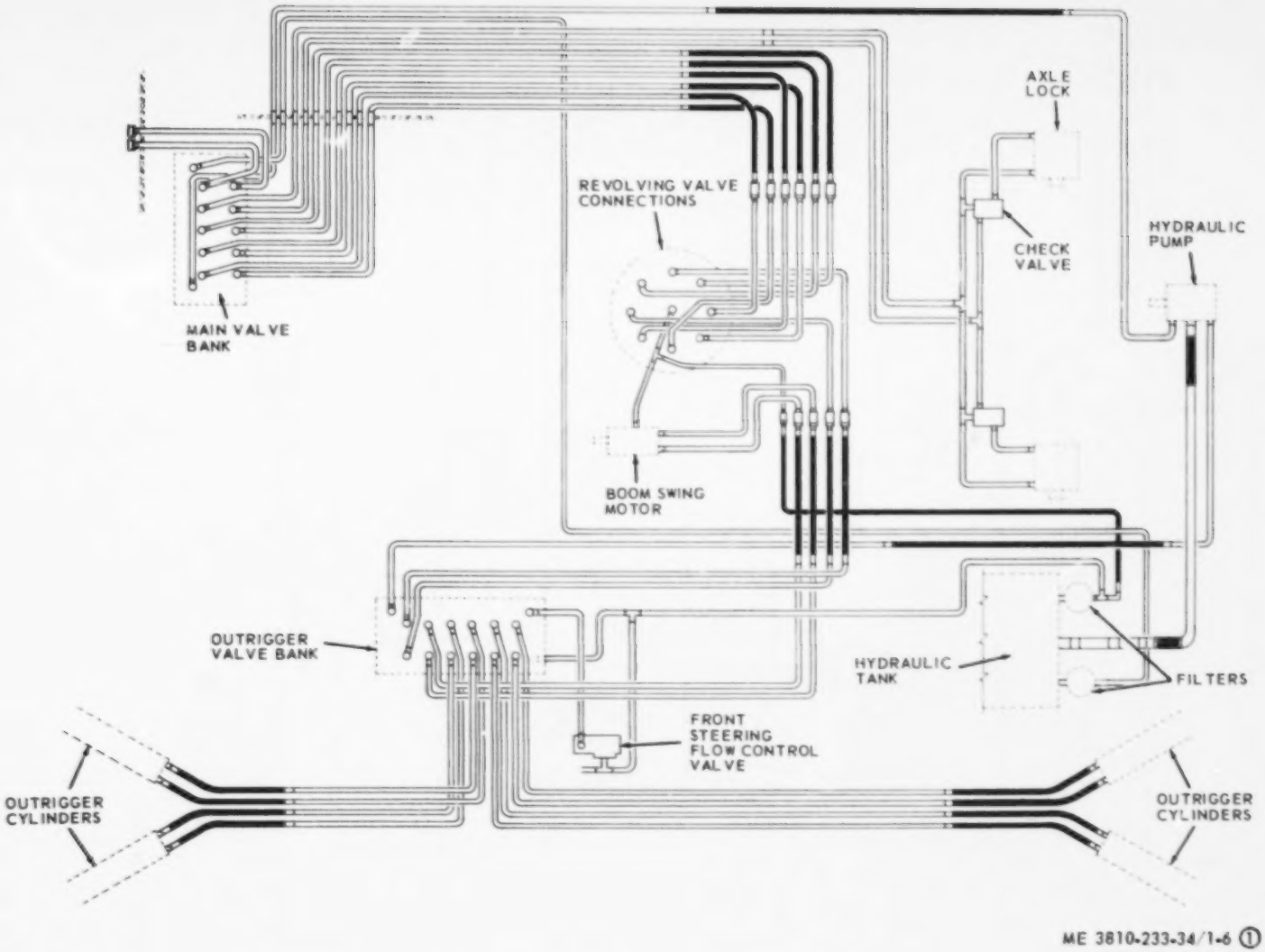


Figure 1-6. Schematic diagram, crane hydraulic system (sheet 1 of 2).

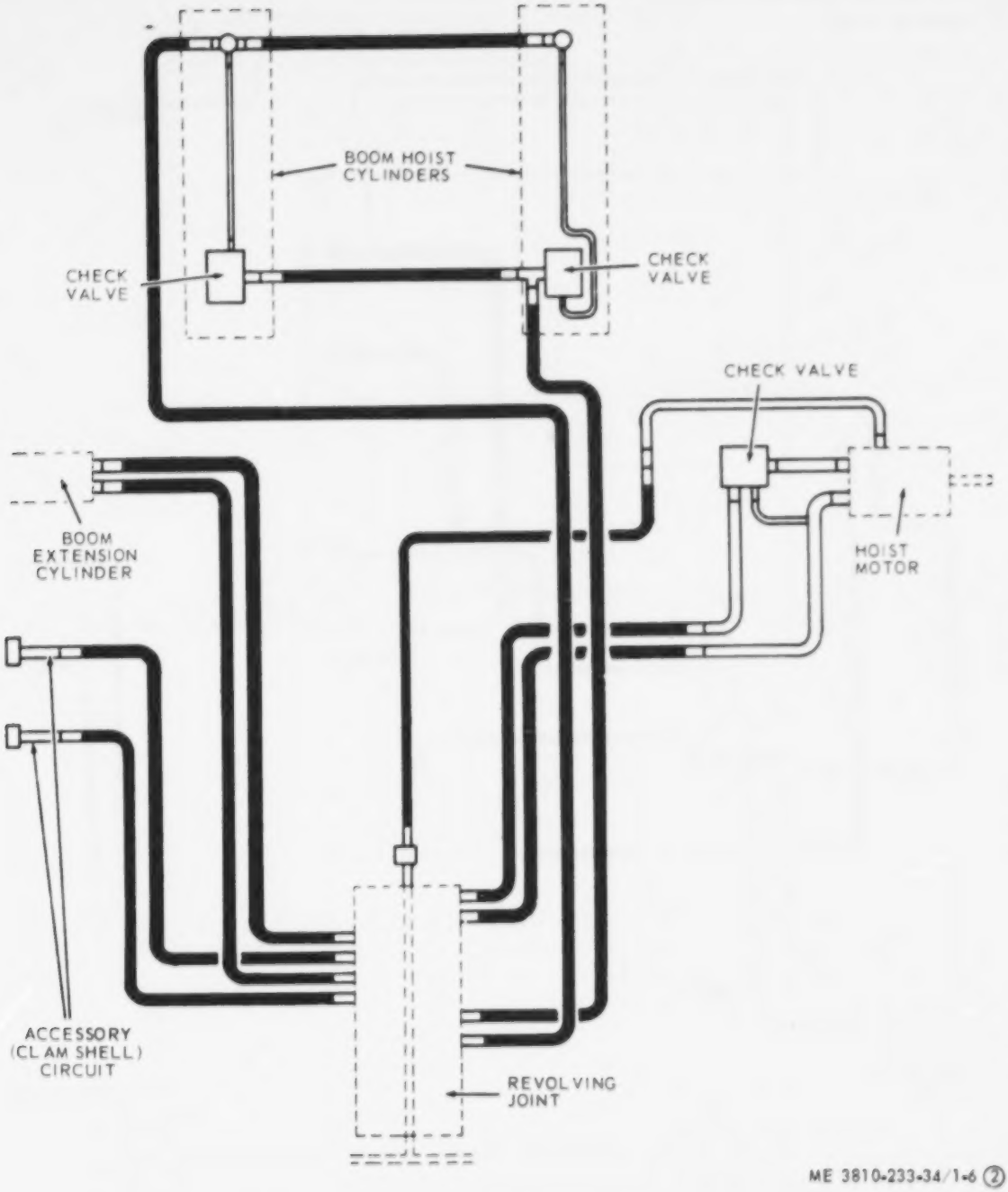


Figure 1-6. Schematic diagram, crane hydraulic system (sheet 2 of 2).

g. Hydraulic Steering System Diagram. Figure 1-7 shows the schematic diagram for the hydraulic steering system.

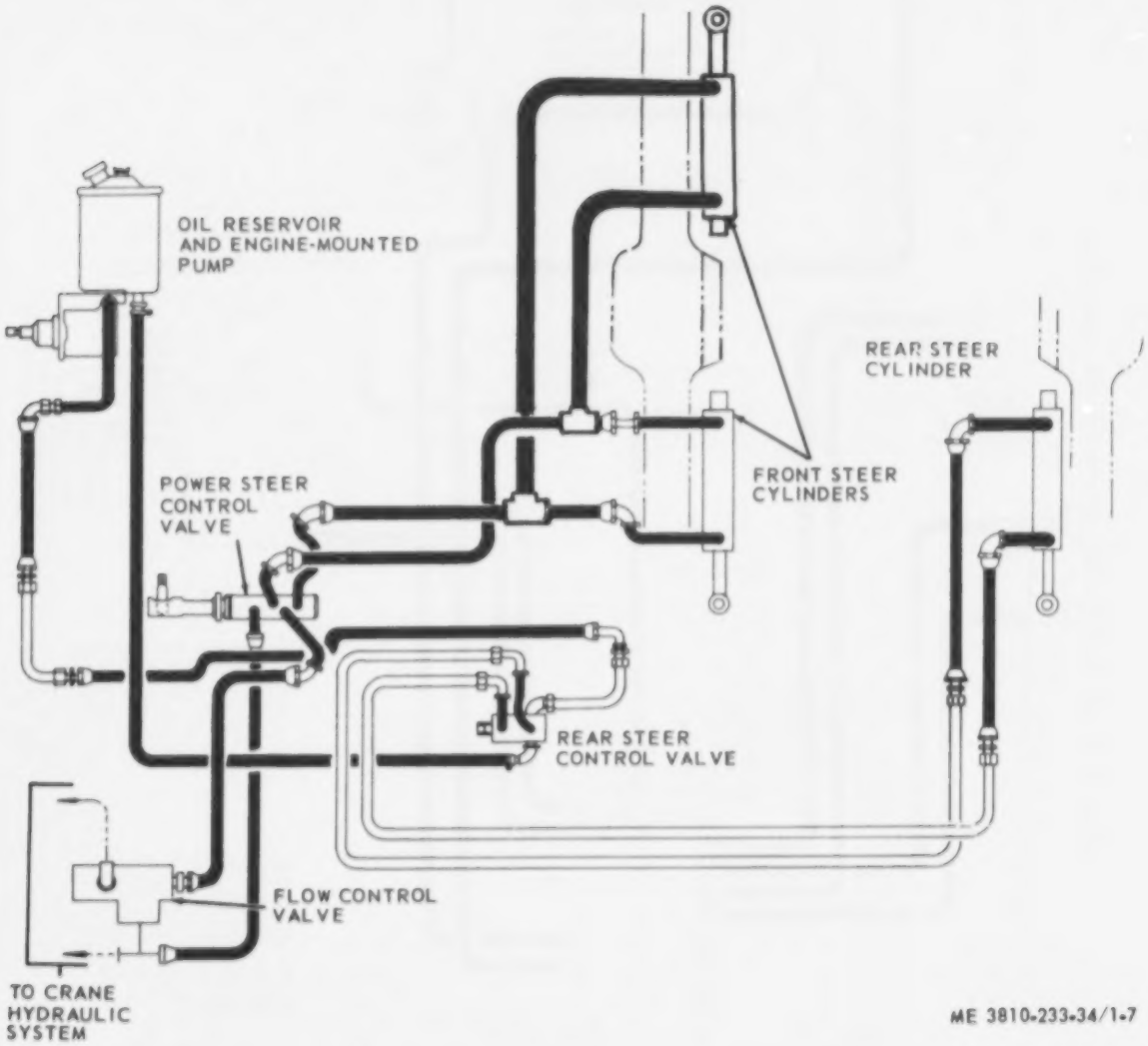
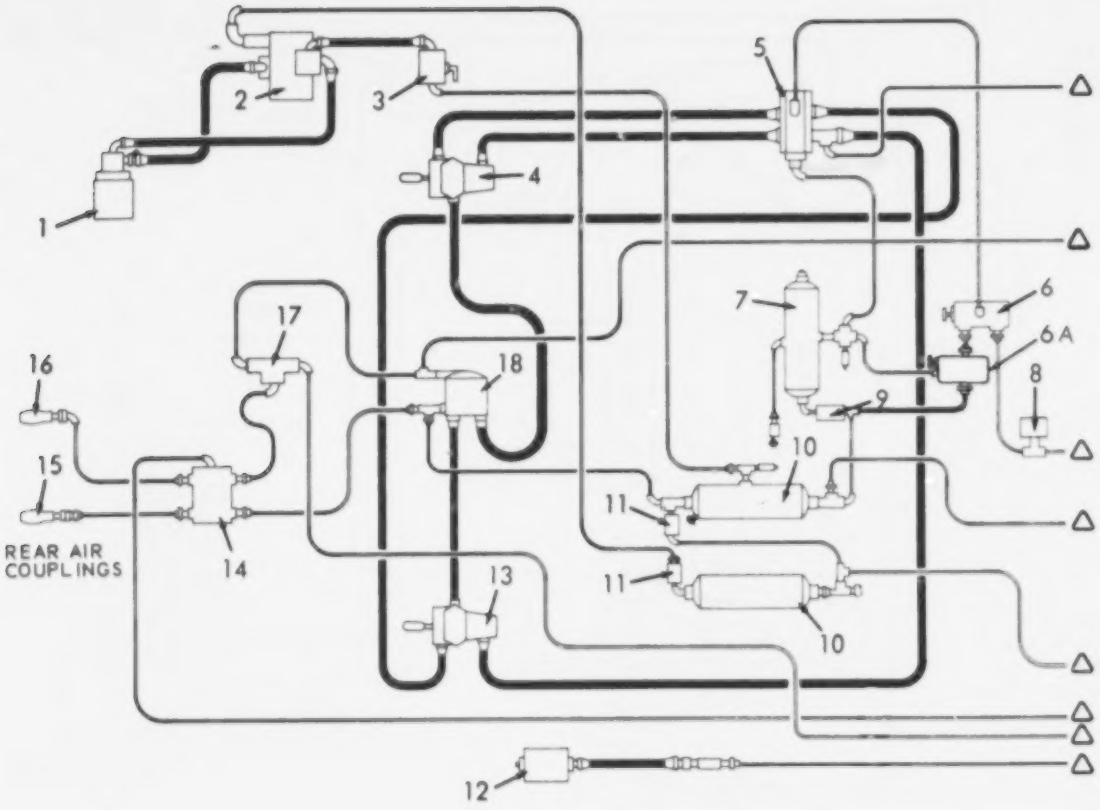


Figure 1-7. Schematic diagram, hydraulic steering system.

h. Crane Air System Diagram. Figure 1-8 shows the schematic diagram for the crane air system.



■ FLEXIBLE HOSE

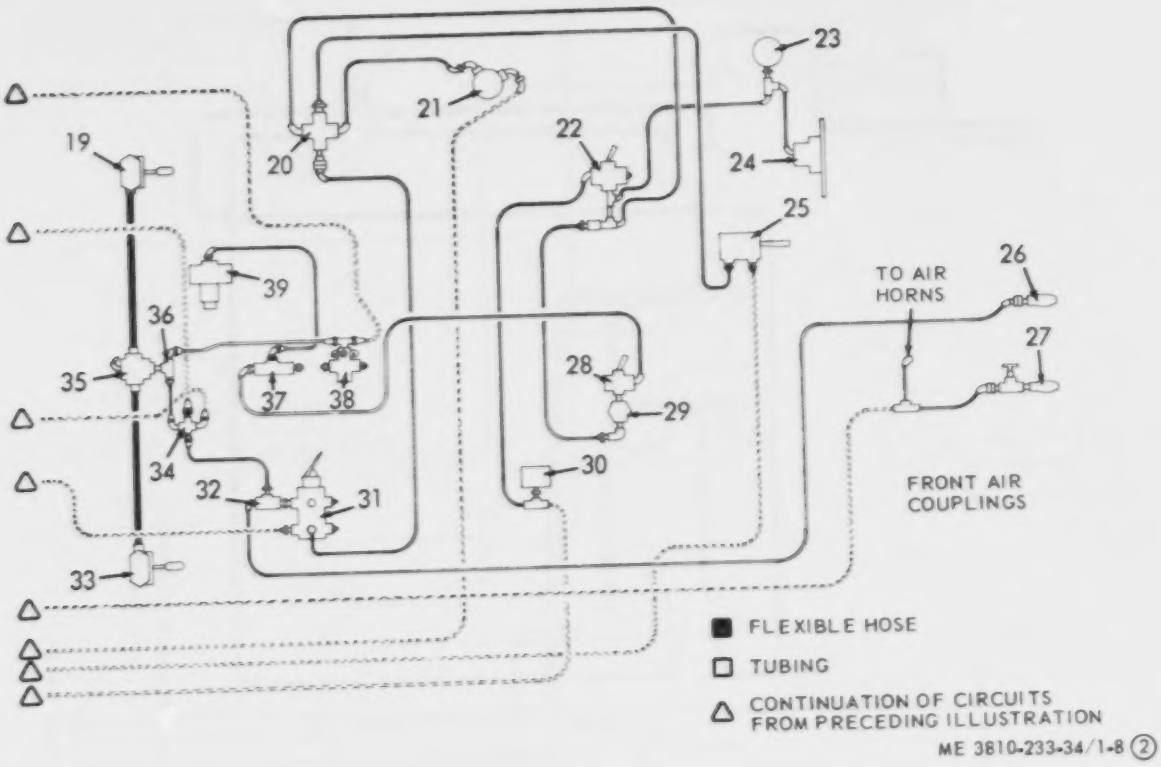
□ TUBING

△ CONTINUED IN FOLLOWING ILLUSTRATION

ME 3810-233-34/1-8 (1)

1 Alcohol evaporator
2 Compressor
3 Air supply valve
4 Brake chamber
5 Inversion valve
6 Emergency control valve
6A Brake valve
7 Emergency air tank
8 Stoplight switch
9 Check valve
10 Main air tanks
11 Check valves
12 Rear steer lock chamber
13 Brake chamber
14 Tractor protection valve
15 Emergency coupling
16 Service coupling
17 2-Way check valve
18 Rear quick-release valve

Figure 1-8. Crane air system, schematic diagram (sheet 1 of 2).



19 Brake chamber
20 Cross-connector
21 Dash Trailer valve
22 Rear axle steering lock valve
23 Air pressure gage
24 Low pressure air switch
25 Air pressure gage
26 Service coupling
27 Emergency coupling
28 Differential lock valve
29 Pressure regulator valve
30 Stoplight switch
31 Air application valve
32 Check valve
33 Brake chamber
34 Cross-connection
35 Front quick-release valve
36 2-way check valve
37 Check valve
38 Limiting and quick release valve
39 Power cluster

Figure 1-8. Crane air system, schematic diagram (sheet 2 of 2).

i. Tractionlock System Diagram. Figure 1-9 shows the schematic diagram for the air-over-hydraulic tractionlock system.

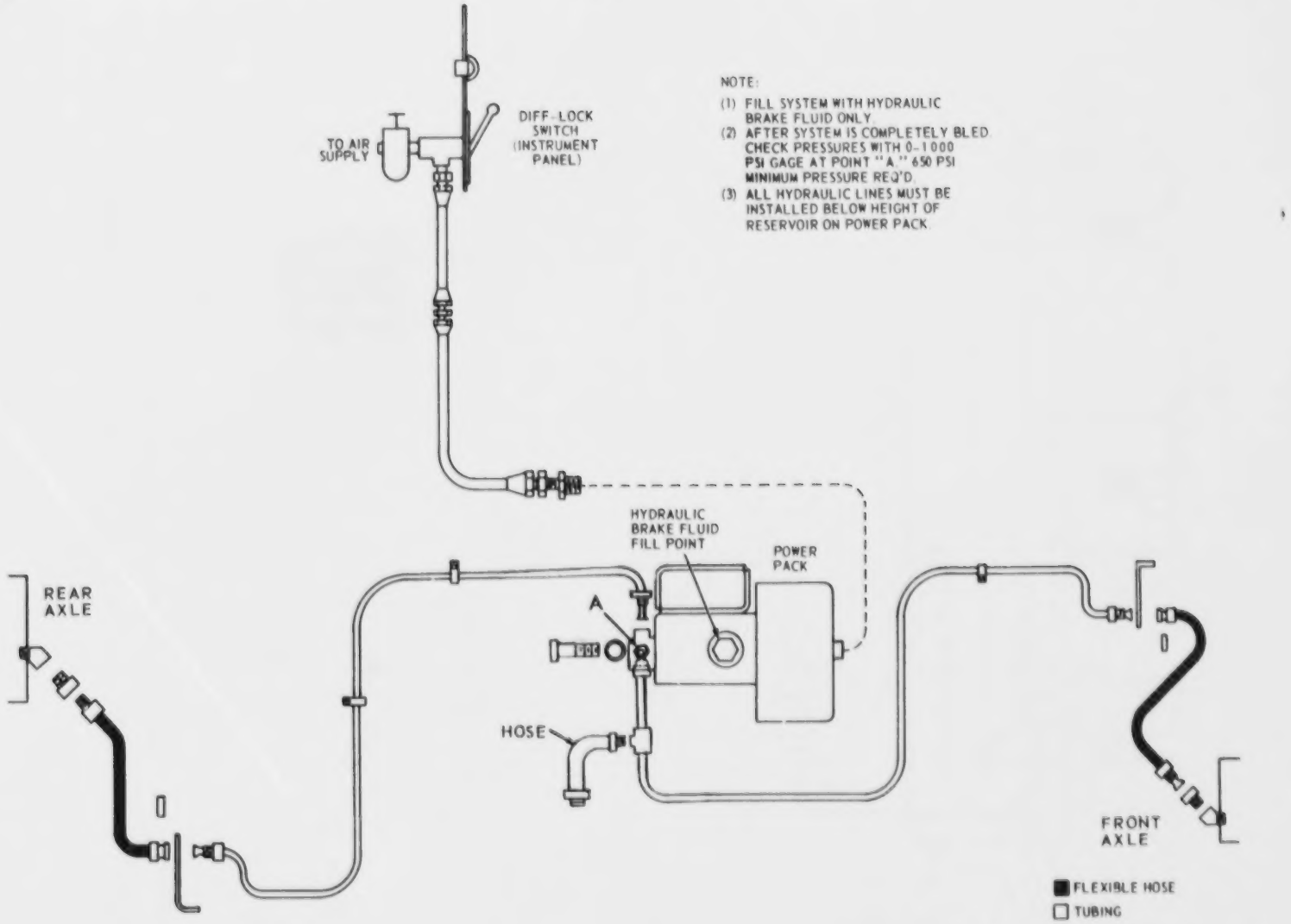

NOTE:
(1) FILL SYSTEM WITH HYDRAULIC BRAKE FLUID ONLY.
(2) AFTER SYSTEM IS COMPLETELY BLED CHECK PRESSURES WITH 0-1000 PSI GAGE AT POINT "A." 650 PSI MINIMUM PRESSURE REQ'D.
(3) ALL HYDRAULIC LINES MUST BE INSTALLED BELOW HEIGHT OF RESERVOIR ON POWER PACK.
TO AIR SUPPLY
DIFF-LOCK SWITCH (INSTRUMENT PANEL)
HYDRAULIC BRAKE FLUID FILL POINT
POWER PACK
A
REAR AXLE
HOSE
FRONT AXLE
FLEXIBLE HOSE
TUBING
ME 3810-233-34/1-9

Figure 1-9. Schematic diagram, air-over-hydraulic tractionlock system.

j. Fuel System Diagram. Figure 1-10 shows the schematic diagram of the engine fuel system.

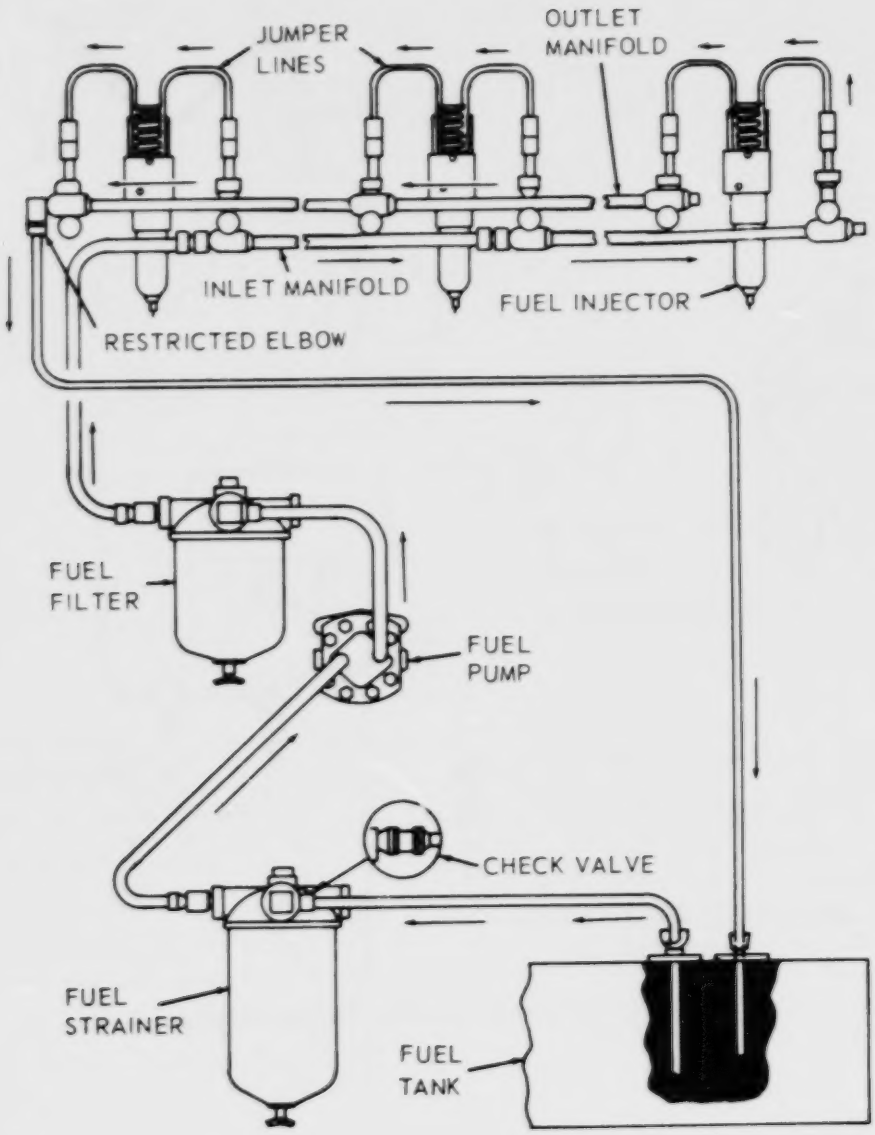


Figure 1-10. Schematic diagram, engine fuel system.

k. Engine Lubrication System Diagram. Figure 1-11 shows the schematic diagram of the engine lubrication system.

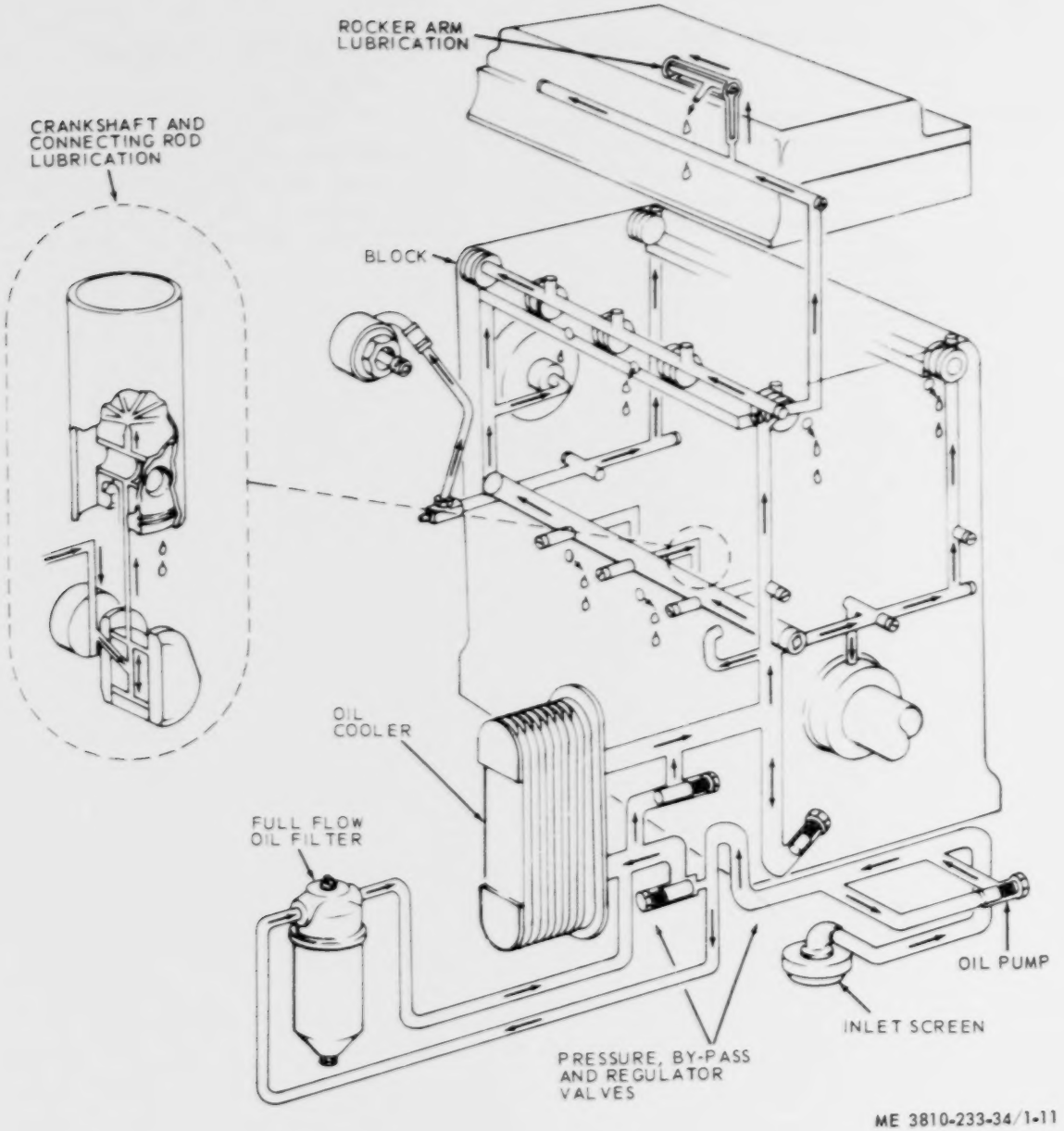


Figure 1-11. Schematic diagram, engine lubricating system.

CHAPTER 2

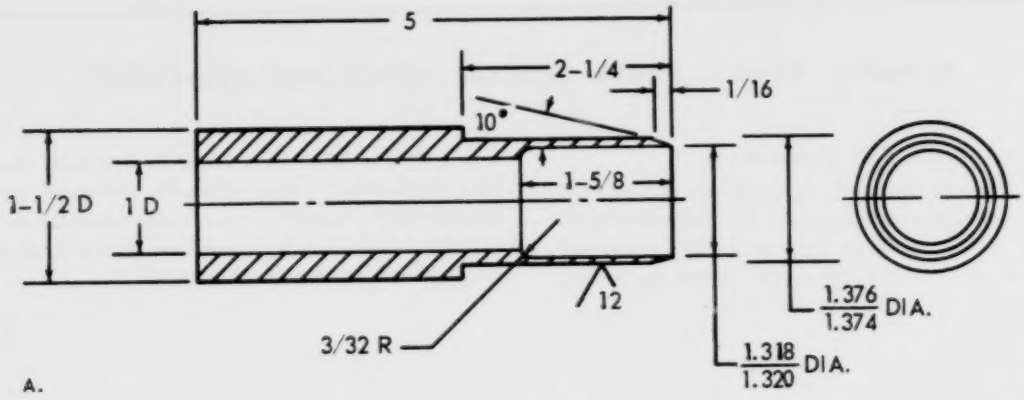
DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS AND EQUIPMENT

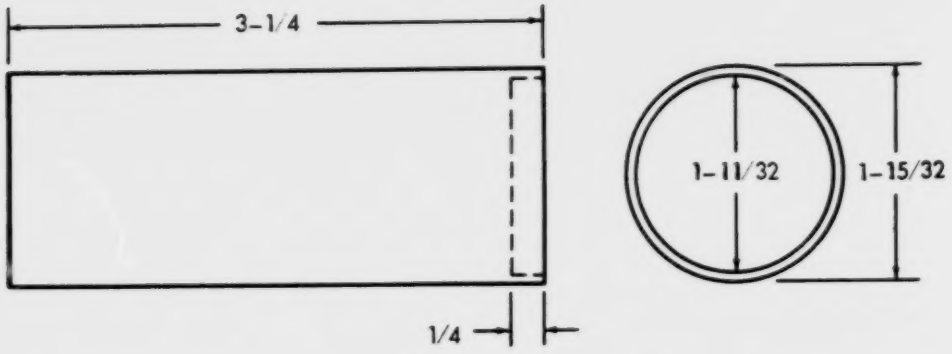
2-1. Special Tools and Equipment

The special tools required to perform direct and general support maintenance on the Model H446 Crane are listed in table 2-1. It includes special tools issued with the Crane and those tools not available for issue that must be specially designed and fabricated. These specially designed tools are illustrated in figure 2-1 with dimensional data and can be fabricated by qualified direct and general support maintenance personnel.

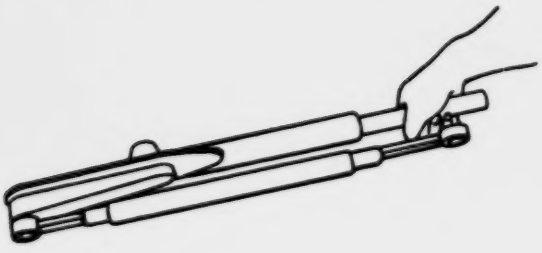
NOTE: ALL DIMENSIONS ARE IN INCHES.



A.

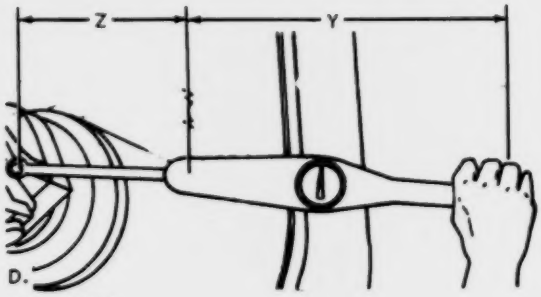


B.



C.

TORQUE WRENCH
2:1 TORQUE MULTIPLICATION



D.

$$C = \frac{Y \times T}{Y + Z}$$

C = DIAL READING (TO BE COMPUTED).
T = TORQUE DESIRED ON BOLT OR NUT.
Y = DISTANCE FROM SQUARE DRIVE TO CENTER OF HAND POSITION
X = DISTANCE FROM CENTER OF TORQUE ADAPTER DRIVE SQUARE TO CENTER OF 12 POINT BOX END. PARALLEL TO CENTERLINE OF TORQUE WRENCH.

ME 3810-233-34/2-1

Figure 2-1. Special Tools

Table 2-1. Special Tools, Test and Support Equipment (Including Fabricated Items)

Item	FSN or Reference No.	Reference		Use	Figure
		Fig No	Para No		
Wrench, special	(23382) 75811		2-10	Removing axle locknuts	
Boxwrench	45225 / MS-36-A		2-10	Tighten ball flange nuts	2-1C
Arm, Extension	45225 / MS-28-18		2-10	Tighten ball flange nuts	2-1C
Drive, sq. ¾ in.	45225 / MS-24-AS	2-3	2-10	Tighten ball flange nuts	2-1C
Pilot, seal			3-2	Installing rotor in alternator	2-1A
Gage, timing	5210-363-7576		3-21	Timing engine	
Driver, seal installing			4-19	Installing seals in crane hydraulic pump	2-1B
Tool set, blower service	J-6270-07		3-39	Assembling blower drive	
	5120-936-4376				
Service tool set	5180-596-8541		3-23	Injector hole tube replacement.	

2-2. Maintenance Repair Parts

Repair parts and equipment are listed and illustrated in the repair parts and special tools list covering direct and general support maintenance for the equipment in TM 5-3810-233-35P.

Section II. TROUBLESHOOTING

2-3. General

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the Hanson Model H446 Rough terrain crane or any of its components. Each trouble symptom is followed by a list of probably causes of trouble. The possible remedy recommended is described opposite the probable cause.

2-4. Troubleshooting

Refer to table 2-2 for direct and general support maintenance troubleshooting.

Table 2-2. Troubleshooting

Malfunction	Probable Cause	Corrective Action
1. Engine fails to start.	*a.* Loose starter connections.	*a.* Repair loose connections in circuit. Repair or replace starting motor (para 3-1).
	b. Defective fuel pump.	*b.* Repair or replace fuel pump (para 3-41).
	c. Injector control racks not in full fuel position.	*c.* Check and adjust injector, fuel control racks to correct position (para 3-13).
	d. Governor not properly adjusted.	*d.* Adjust governor (para 3-21).
2. Engine hard to start.	*a.* Exhaust valves sticking or burned.	*a.* Clean and / or replace exhaust valves (para 3-25).
	b. Compression rings broken.	*b.* Replace compression rings (para 3-33, 3-34).
	c. Cylinder head gasket leaking.	*c.* Replace cylinder head gasket (para 3-23).
	d. Incorrect exhaust valve clearance adjustment.	*d.* Adjust exhaust valves (para 3-25).
	e. Injectors dirty or defective.	*e.* Clean and / or repair defective injectors (para 3-15).
	f. Blower not functioning properly.	*f.* Replace or repair defective blower (para 3-40).
	g. Air inlet valve not functioning.	*g.* Replace or repair air inlet assembly (para 3-38).
3. Engine stops suddenly.	*a.* Limiting speed governor defective.	*a.* Replace or repair limiting speed governor (para 3-43).
	b. Fuel pump inoperative.	*b.* Replace or repair fuel pump (para 3-42).
	c. Air intake blocked.	*c.* Repair air inlet system (para 3-38).

Table 2-2. Troubleshooting (continued)

Malfunction	Probable Cause	Corrective Action
4. Engine Knocks or develops excessive noise.	*a.* Piston pin loose.	*a.* Locate the loose pistons pins by deactivating the injectors in turn until the noise stops. Replace a defective piston pin and bushings (para 3-34).
	b. Piston or cylinder liner broken.	*b.* Replace the piston (para 3-34). Replace the cylinder liner (para 3-72).
	c. Connecting rod bearings worn or loose.	*c.* Replace defective connecting rod bearings (para 3-34).
	d. Injector spray tip valve leaky.	*d.* Repair or replace a faulty injector (para 3-17 thru 3-20).
	e. Blower bearings worn.	*e.* Replace or repair the blower (para 3-40).
	f. Blower end plates loose.	*f.* Tighten the end plate capscrews (para 3-40).
	g. Blower rotor end play excessive.	*g.* Disassemble the blower and add shims as required (para 3-40).
	h. Gear train defective.	*h.* Repair or replace the gear train (para 3-64 thru 3-68).
	i. Main bearings worn.	*i.* Replace the main bearings (para 3-68).
	j. Crankshaft worn, tapered, or out-of-round.	*j.* Repair or replace the crankshaft (para 3-68).
	k. Crankshaft end clearance excessive.	*k.* Replace the crankshaft thrust washers (para 3-68).
	l. Flywheel loose.	*l.* Tighten the flywheel mounting capscrews (para 3-59).
5. Engine misses or runs erratically.	*a.* Injector control tube improperly adjusted.	*a.* Adjust the injector control tube (para 3-13).
	b. Fuel injectors out of time.	*b.* Time the fuel injectors (para 3-21).
	c. Fuel injectors faulty.	*c.* Repair or replace faulty fuel injectors (para 3-15).
	d. Cylinder compression low.	*d.* Inspect for broken pistons and worn or broken rings (para 3-34). Inspect for scored liners (para 3-34). Replace pistons and rings (para 3-34). Replace damaged liners (3-72).
	e. Exhaust valves sticking or burned.	*e.* Replace the exhaust valves and seats (para 3-25).
6. Engine lacks power	*a.* Injector control tube improperly adjusted.	*a.* Adjust the injector control tube (para 3-13).
	b. Fuel injectors out of time.	*b.* Time the fuel injectors (para 3-21).
	c. Fuel injectors faulty.	*c.* Repair or replace faulty fuel injectors (para 3-15).
	d. Cylinder compression low.	*d.* Inspect for broken pistons and piston rings (para 3-34). Inspect for scored liners (para 3-71). Replace pistons and rings (para 3-34). Replace damaged liners (para 3-72).
	e. Exhaust valves sticking or burned.	*e.* Replace the exhaust valves and seats (para 3-25).
	f. Fuel pump faulty.	*f.* Repair or replace the fuel pump (para 3-21).
	g. Cylinder sleeve air inlet ports clogged.	*g.* Clean the inlet ports (para 3-71).
7. Engine Exhaust smoky	*a.* Fuel injector timing improper.	*a.* Time the fuel injectors (para 3-21).
	b. Fuel injector control tube out of adjustment.	*b.* Adjust the fuel injector control tube (para 3-16).
	c. Fuel injectors faulty.	*c.* Repair or replace faulty fuel injectors (para 3-15).
	d. Piston rings worn or broken.	*d.* Replace the piston rings (para 3-34).
	e. Exhaust valves not seating properly.	*e.* Replace the exhaust valves or valve seats (para 3-25).

Table 2-2. Troubleshooting (continued)

Malfunction	Probable Cause	Corrective Action
8. Engine overheats	*a.* Water pump defective.	*a.* Repair or replace the water pump (para 3-55).
	b. Radiator defective.	*b.* Repair or replace the radiator (para 3-53).
	c. Coolant passages in cylinder block clogged.	*c.* Clean the cylinder block (para 3-71).
	d. Lube oil gallery in cylinder block plugged.	*d.* Clean the oil gallery in the cylinder block (para 3-71).
	e. Cylinder block cracked.	*e.* Replace the cylinder block (para 3-70).
9. Engine has low or no oil pressure.	*a.* Connecting rod bearings, crankshaft, or main bearings worn.	*a.* Replace the connecting rod bearings (para 3-34). Replace the crankshaft or main bearings (para 3-68).
	b. Oil pump relief valve sticking.	*b.* Clean, repair, or replace the relief valve (para 3-28).
	c. Oil pump screen clogged.	*c.* Clean the oil pump screen (para 3-28).
	d. Oil pump defective.	*d.* Repair or replace the oil pump (para 3-28).
	e. Lubricating oil diluted with fuel oil.	*e.* Replace the injector preformed packing (para 3-16).
10. Engine oil consumption high	*a.* Oil pan gasket defective.	*a.* Replace the gasket (para 3-27).
	b. Crankshaft oil seal defective.	*b.* Replace the crankshaft oil seal (para 3-68).
	c. Blower oil seal defective.	*c.* Replace the oil seal (para 3-40).
	d. Cylinder block end plates gaskets leaking.	*d.* Replace the gaskets (para 3-72).
	e. Oil control rings worn, broken, or improperly installed.	*e.* Replace the oil control rings (para 3-34).
	f. Pistons and cylinder liners worn.	*f.* Replace the worn pistons (para 3-34). Replace the worn liners (para 3-72).
11. Cable hoist inoperative or operates sluggishly	*a.* Low hydraulic pressure.	*a.* Clean tank, filters, and lines TM 5-3810-233-12). Repair or replace crane hydraulic pump (para 4-19).
	b. Defective hydraulic motor	*b.* Repair or replace hydraulic motor (para 4-9).
	c. Excessive friction in hoist gear drive assembly.	*c.* Repair or replace hoist gear drive assembly (para 4-10).
	d. Defective multi-unit control valve.	*d.* Repair or replace multi-unit control valve (para 4-20).
12. Boom swing inoperative or operates sluggishly	*a.* Low hydraulic pressure.	*a.* Clean tank, filters, and lines TM 5-3810-233-12). Repair or replace crane hydraulic pump (para 4-19).
	b. Defective boom swing motor.	*b.* Repair or replace boom swing motor (para 4-13).
	c. Excessive friction in boom swing gear assembly.	*c.* Repair or replace the boom swing gear drive assembly (para 4-14).
	d. Defective multi-unit control valve.	*d.* Repair or replace multi-unit control valve (para 4-20).
	e. Worn bearings on upper turret sleeve.	*e.* Replace upper turret roller bearings (para 4-16).
13. Boom hoist inoperative or operates sluggishly	*a.* Low hydraulic pressure.	*a.* Clean tank, filters, and lines (TM 5-3810-233-12). Repair or replace crane hydraulic pump (para 4-19).
	b. Defective boom hoist cylinder.	*b.* Repair or replace the boom hoist cylinders (para 4-6).
	c. Defective rotary seal unit.	*c.* Replace the rotary seal unit (para 4-15).
	d. Defective multi-unit control valve.	*d.* Repair or replace multi-unit control valve (para 4-20).

Table 2-2. Troubleshooting (continued)

Malfunction	Probable Cause	Corrective Action
14. Boom extension inoperative or operates sluggishly	*a.* Low hydraulic pressure.	*a.* Clean tank, filters, and lines (TM 5-3810-233-12). Repair or replace crane hydraulic pump (para 4-19).
	b. Defective boom extension cylinder.	*b.* Repair or replace the boom extension cylinder (para 4-5).
	c. Wear shoes excessively worn.	*c.* Replace wear shoes (para 4-7).
	d. Defective multi-unit control valve.	*d.* Repair or replace multi-unit control valve (para 4-20).
	e. Eccentric roller requires adjusting.	*e.* Adjust roller as required (para 4-7).
15. Hydraulic steering system sluggish or inoperative	*a.* Low hydraulic pressure.	*a.* Clean tank, filters, and lines (TM 5-3810-233-12). Repair or replace crane hydraulic pump (para 4-19). Repair or replace engine-mounted hydraulic pump (para 3-74).
	b. Defective flow control valve and/or power steer control valve.	*b.* Replace defective flow control valve. Repair or replace power steer control valve (para 8-2).
	c. Defective steering cylinder(s).	*c.* Repair or replace hydraulic steering cylinders (para 8-4).
	d. Defective engine-mounted hydraulic pump.	*d.* Repair or replace rear steering pump (para 3-74).
	e. Defective rear steering valve.	*e.* Repair or replace rear steering valve (para 8-6).
	f. Defective rear steering axle locking assembly.	*f.* Repair or replace rear steer locking assembly (TM 5-3810-233-12).
16. Loss of power from transmission	*a.* Clutch plate slippage.	*a.* Inspect transmission for worn piston seals. Repair or replace transmission (para 5-7).
	b. Defective clutch control valve.	*b.* Repair or replace control valve (para 5-5).
	c. Defective oil pump.	*c.* Repair or replace oil pump (para 5-9).
	d. Defective torque converter.	*d.* Perform stall test (para 5-7).
17. Power transmitted in only one direction	*a.* Broken seal rings on output shaft.	*a.* Repair or replace shaft and clutch assemblies (para 5-8).
	b. Defective clutch assembly.	*b.* Repair or replace clutch assembly (para 5-8).
18. Noisy transmission	*a.* Air leaks.	*a.* Inspect for air leaks around oil tubes, seals, and gaskets (para 5-7).
	b. Damaged gear teeth.	*b.* Inspect, repair and/or replace transmission (para 5-6).
	c. Damaged gear shaft.	*c.* Repair or replace transmission (para 5-6).
	d. Flywheel housing misalinement.	*d.* Realine flywheel housing with indicator (para 3-60).
	e. Loose mounting bolts.	*e.* Tighten mounting bolts to specified torque (para 3-60).
19. Carrier fails to move in either direction.	Defective transfer case assembly.	Repair or replace transfer case (para 6-2).
20. Wheel(s) lose traction	Defective traction-lock power cluster.	Repair or replace power cluster (para 6-6).

Section III. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS

2-5. Cab Assembly

a. Removal. Remove the cab assembly (TM 5-3810-233-12).

b. Installation. Install the cab assembly (TM 5-3810-233-12).

2-6. Crane Superstructure

a. Removal. Remove the crane superstructure (TM 5-3810-233-12).

b. Installation. Install the crane superstructure (TM 5-3810-233-12).

2-7. Engine Assembly

a. Removal.

(1) Remove the engine hood (TM 5-3810-233-12).

(2) Disconnect and remove all throttle linkage from engine. Remove fuel line from fuel strainer (TM 5-3810-233-12). Disconnect stop control wire at the air inlet housing (para 3-38).

(3) Remove the radiator (para 3-53).

(4) Remove the exhaust muffler (TM 5-3810-233-12).

(5) Disconnect the alternator leads and starter connections (TM 5-3810-233-12).

(6) Remove the oil filter assembly (TM 5-3810-233-12).

(7) Remove the cab and crane superstructure as outlined in paragraphs 2-5 and 2-6 above.

(8) Attach a lifting sling to the engine lifter brackets mounted on the balance weight cover and flywheel housing.

(9) Disconnect the short drive shaft at rear of 4-speed transmission. Disconnect all control linkage to transmission. Disconnect hydraulic lines.

(10) Remove the capscrews (17 and 19, fig. 2-2), washers (3 and 20), and nuts (14 and 21) from the engine mountings. Remove the nuts (12), washers (8), and capscrews (7) from the transmission mountings.

(11) Remove engine and transmission from the carrier frame with a suitable hoist and place on a work stand. Remove the transmission from the engine.

b. Installation.

(1) Install by assembling engine and transmission; place the assembly in the carrier frame, and secure with the hardware described above.

NOTE

Install new insulators (shock mounts) (13 and 15) when replacing the assembly.

(2) Complete the installation in the reverse order of disassembly.

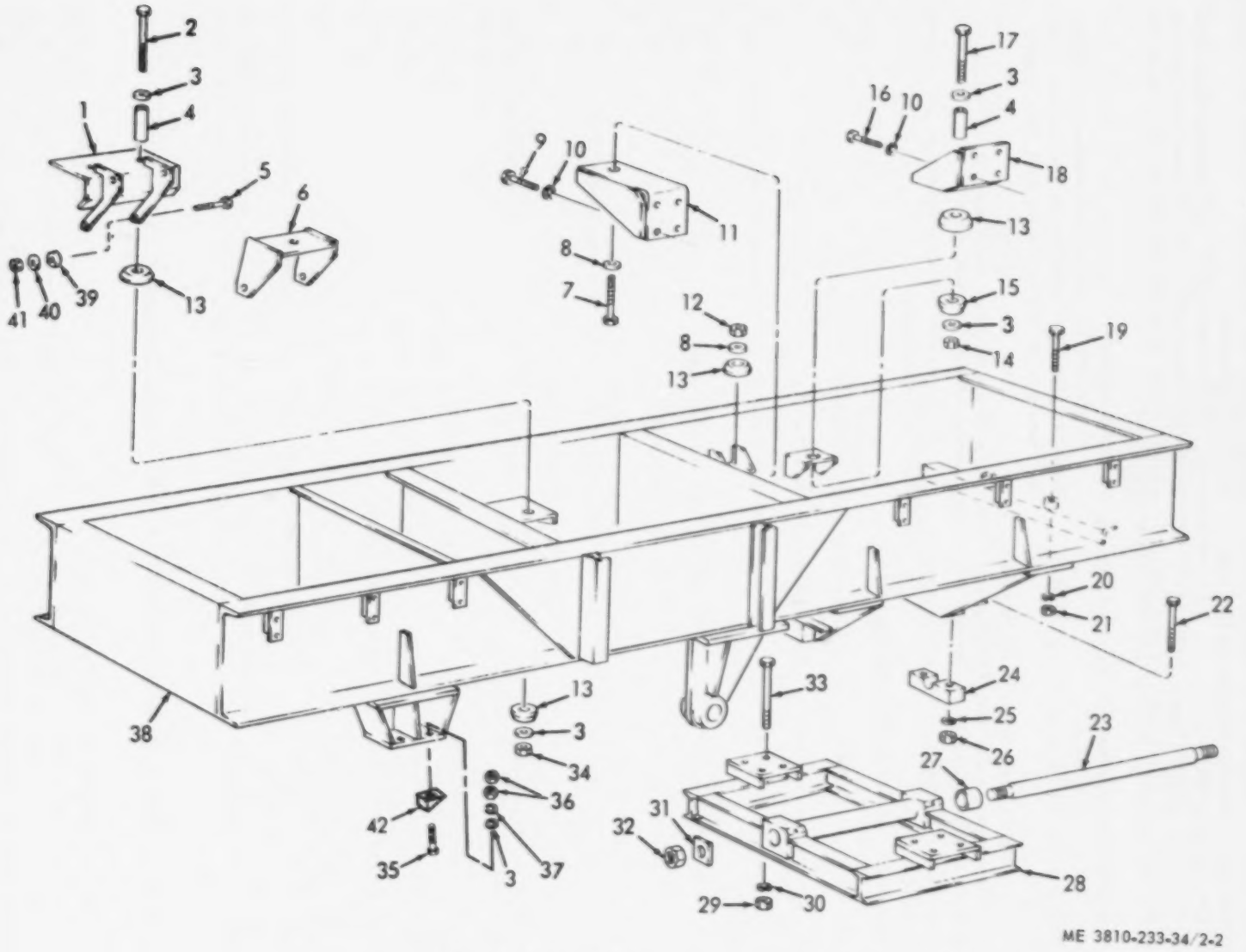


Figure 2-2. Carrier frame and major components mounting details, exploded view.

Key to figure 2-2:

1 Bracket
2 Capscrew
3 Washer
4 Sleeve
5 Capscrew
6 Bracket
7 Capscrew
8 Washer
9 Capscrew
10 Lockwasher
11 Bracket
12 Nut
13 Insulator
14 Nut
15 Insulator
16 Capscrew
17 Capscrew
18 Bracket
19 Capscrew
20 Lockwasher
21 Nut
22 Capscrew
23 Shaft
24 Cap
25 Lockwasher
26 Nut
27 Spacer
28 Pivot frame
29 Nut
30 Lockwasher
31 Washer
32 Nut
33 Capscrew
34 Nut
35 Capscrew
36 Nut
37 Lockwasher
38 Frame assy.
39 Spacer
40 Lockwasher
41 Nut
42 Beveled washer

2-8. Transmission and Torque Converter

a. Removal.

(1) Remove the engine hood and crane superstructure (TM 5-3810-233-12).

(2) Disconnect and remove the short drive shaft between the transmission and transfer case. Drain the transmission. Disconnect all control linkage to the transmission. Disconnect all hydraulic lines. Remove the hydraulic steering pump (para 3-74) and air compressor (para 3-48). Remove the support tube (44, fig. 5-4) and cover plate (43) from the shaft (22).

(3) Remove the capscrews (4 and 24, fig. 5-7) and washers (3 and 25) that attach the converter housing to the engine flywheel housing.

(4) Attach a sling to the transmission assembly. Tension the sling very lightly with a suitable lifting device.

(5) Remove the nuts (12, fig. 2-2), washers (8), insulators (13), and capscrews (7).

(6) Carefully pry the transmission assembly away from the engine to disengage the converter housing.

(7) Lift out the transmission assembly and place on a work stand.

b. Installation.

(1) Install the transmission assembly in the carrier frame. Aline converter housing with flywheel housing and carefully slide into place. Install the converter housing bolts and tighten alternately around the housing perimeter to assure proper mating of the two housings. *Do not tighten.*

(2) Install the mounting hardware as described in *e* above. Tighten the converter housing bolts to the torque specified for the bolt size in table 1.

(3) Install control linkage and hose. Install assemblies in reverse order of removal. Service the transmission in accordance with current lubrication order.

2-9. Transfer Case

a. Removal.

(1) Remove cab and crane superstructure (para 2-5 and 2-6).

(2) Disconnect the three universal joints connecting the drive shafts.

(3) Disconnect the shift control linkage and hydraulic lines.

(4) Attach a sling to the transfer case. Remove the nuts (34, fig. 2-2), washers (3), capscrews (2), sleeves (4), and insulators (13 and 16).

(5) Lift out the transfer case and place on a work stand.

b. Installation. Install the transfer case in the reverse order of removal. Service in accordance with current lubrication order.

2-10. Front and Rear Axles

a. General.

(1) Jack up the carrier frame sufficiently to provide clearance for removal of the wheels.

CAUTION

Install adequate blocking to support the carrier.

(2) Disconnect the drive shaft at the universal joint at each axle. Disconnect the hydraulic lines connected to each steering cylinder.

(3) Remove the wheels.

b. Front Axle Removal

(1) Disconnecting the power steer control arm at the drag link end, and the air lines at the brake chambers. Remove one brake chamber.

(2) Place a dolly under the axle and install sufficient blocking to support the axle.

(3) Remove the nuts (36, fig. 2-2), lockwashers (37), and capscrews (35).

(4) Remove the axle by pulling out the dolly from the side of the crane. Place the axle on a suitable work stand or supports.

c. Rear Axle Removal

(1) Disconnect the air lines to the brake chambers and lock chamber. Remove one brake chamber. Place a dolly under the axle and install sufficient blocking to support the axle.

(2) Remove the nuts (26, fig. 2-2), lockwashers (25), and caps (24)., Remove sufficient blocking order that the pivot frame (28) will clear the carrier frame.

(3) Remove axle by pulling out the dolly from the side of the crane.

(4) Remove the nuts (29), lockwashers (30), capscrews (33), and the pivot frame (28) from the axle. Place the axle on a suitable work stand or supports.

d. Front Axle Installation.

(1) Install the front axle in reverse order of removal.

(2) Pre-load the bearing on both sides of the front axle, do the right side as follows, and repeat for the left side.

(a) Assure that the wheel is straight.

(b) Level the new trunnion plate using a bubble level on top of the plate by lowering the front side of the axle.

(c) Attach a spring scale to a rim mounting stud as shown in figure 2-3.

(d) Take a reading in both directions when the wheel begins to move. An average should be obtained between the two readings of 19-21 lbs. This results in a bearing pre-load of 25 ft-lbs.

(e) If the average pull is less than 19-21 lbs., reduce the shim thickness by the same amount for the bottom steering arm and the top trunnion plate. If the average pull is greater than 19-21 lbs., increase the shim thickness the same amount for the bottom steering arm and the top trunnion plate. Use shims with thickness of .005, .010, and .015. Retorque the four steering arm nuts and the four trunnion plate nuts each time that shims are changed, before checking the average pull.

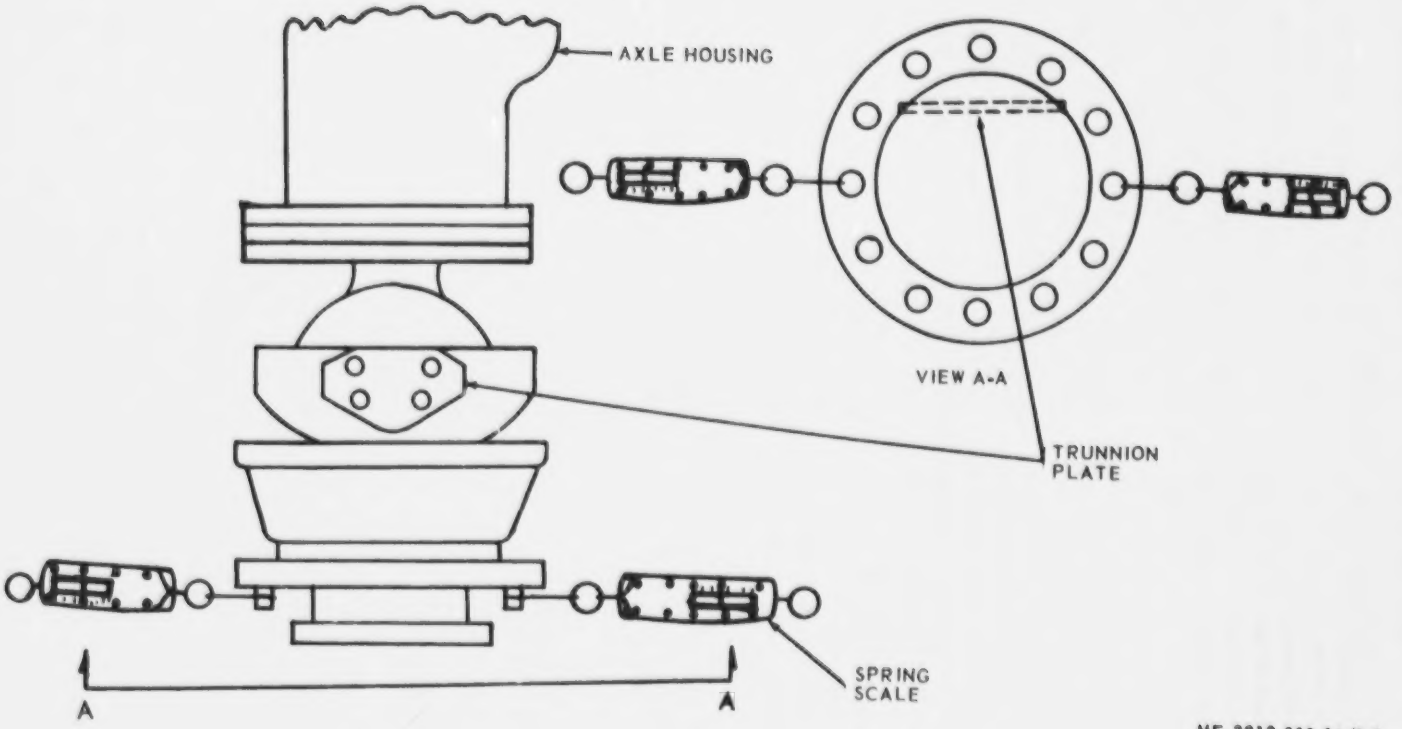


Figure 2-3. Pre-loading the axle bearings.

(3) Check the studs connecting the front axle housing to the left and right ball socket to assure that the one capscrew is adjacent to the slack adjuster.

(4) Torque the nut (44, fig. 7-3) from 370 to 390 ft-lbs. using the special wrench arrangement, the box-wrench, extension arms, and the square 3 / 4 inch drive.

(5) For a 2 to 1 torque multiplication, grip the torque wrench at a distance from the drive end equal to the length of the extension. To measure this length, attach the extension as shown in figure 2-1C, and center your grip over the box wrench. (This is for determining grip position only. The extension must be repositioned in the extended position when used). When this grip position is used, the torque being applied to the bolt is twice the dial reading. The same result is obtained by using formula shown in figure 2-1D. The extensions double the distance from the bolt to the grip—As a result, the effort to achieve any given torque is reduced by 50 percent. For instance, the 150 lb. pull required to achieve a 300 lb-ft. torque on a bolt is reduced to a 75 lb. pull for the same torque.

NOTE

All other hardware shall be tightened to standard torque requirements unless otherwise specified. Refer to table 1-2.

(6) Pre-load the skein bearing to 25 ft-lbs. of torque.

(a) Wrap a wire around the hub at the 15⅛ diameter.

(b) Use a spring scale on the wire and tighten the skein nut with a wrench (table 2-1) until a pull of from 15 to 20 pounds is obtained while rotating the hub. If the skein nut wrench will not fit, grind the teeth fillet radii as required to fit.

(c) Install the special keys to the nut. It may be necessary to back off the nut to install the keys.

e. Rear Axle Installation.

(1) Inspect and replace any damaged or excessively worn parts on the pivot frame before replacing the axle.

(2) Install the rear axle in the reverse order of removal.

(3) Pre-load the rear axle bearing using the procedure described for the front axle bearing.

CHAPTER 3

REPAIR OF ENGINE ASSEMBLY

Section I. ENGINE ACCESSORIES

3-1. Starting Motor Assembly

a. General.

(1) The 24-volt starting motor, with integral starting solenoid and shift, is mounted on the flywheel housing. Remote control starting is accomplished by the starter switch on the crane instrument panel, which upon being closed, energizes the starter solenoid and engages the starter drive pinion with the flywheel ring gear. The starter drive pinion is disengaged from the flywheel ring gear by the reversal of torque when the engine starts.

(2) Failure of the starting motor to crank the engine at normal cranking speed may be due to a defective battery, worn battery cables, poor connections, condition of the engine, or a defective starting motor. Check the engine, battery and cranking circuit before disassemblying the starting motor.

b. Removal. Remove the starting motor, (TM 5-3810-233-12).

c. Disassembly.

(1) Remove the four screws (1, fig. 3-1) and the solenoid assembly (2) from the starter frame (39).

(2) Remove three screws (3) and washers (4) and remove the frame end (5).

(3) Remove the screws (6, 8, and 10), washers (7 and 9), brushes (11), and spring (12) from the starter.

(4) Remove the screws (13), washers (14), brush holders (15), plates (16 and 17), and washers (18) from the frame end (5).

(5) Remove the five mounting screws (19), the screw (20), the drive housing (21), and packing (22). Remove the lever shaft (23), packing (24), washer (25), and clutch assembly (26). Remove the plunger assembly (27).

(6) Remove the five screws (28) and washers (29), that secure the lever housing (30) to the starter. Remove the lever housing (30).

(7) Remove the armature (31) and washer (32) from the starter frame (39).

(8) Remove the bushing (33), seal (34), washer (35), coil assembly (36) and insulation (37).

(9) Remove the terminal stud assembly (38) from the starter frame (39).

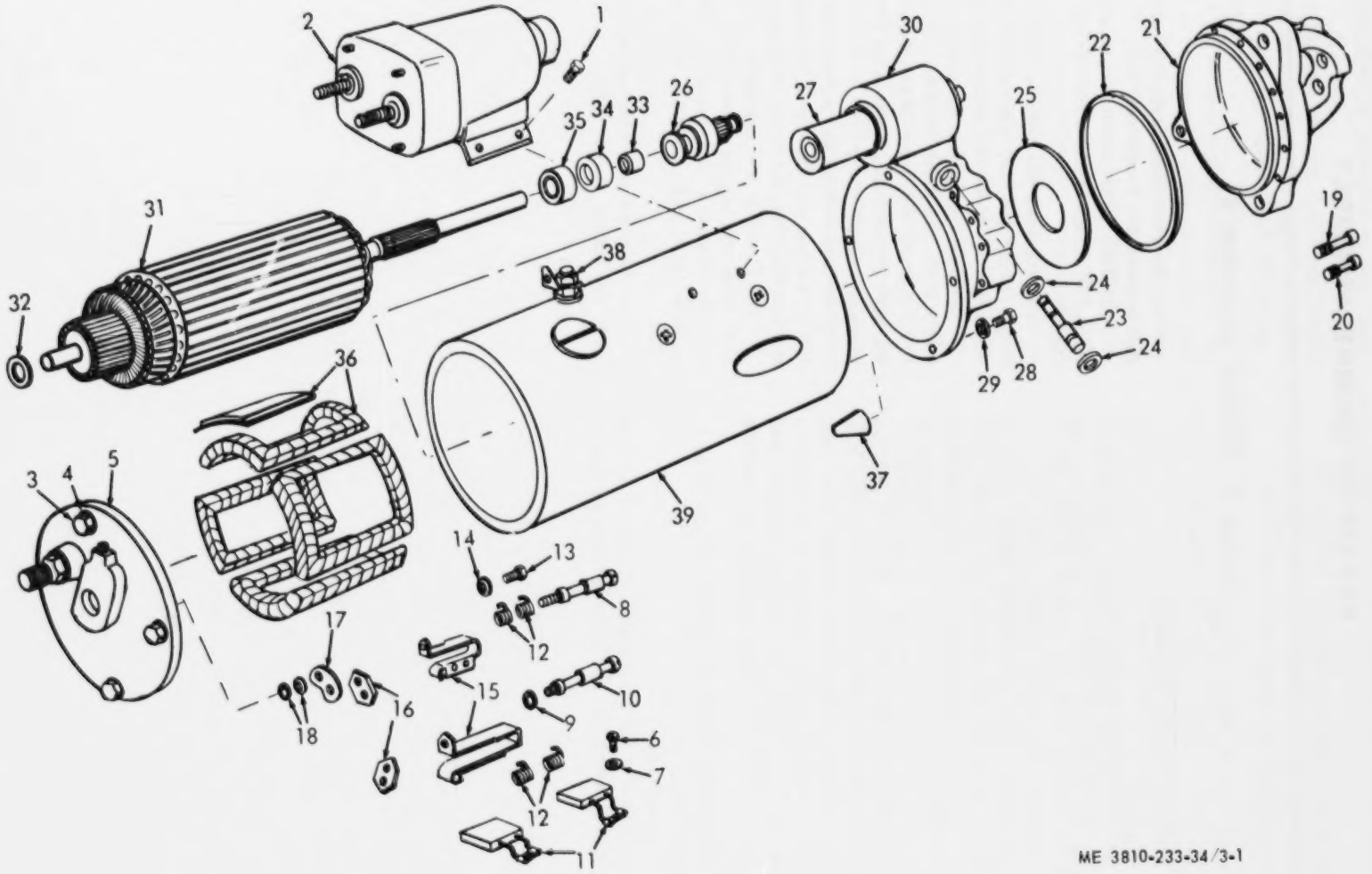


Figure 3-1. Starting motor assembly, exploded view.

Key to figure 3-1:

1 Screw
2 Solenoid assembly
3 Screw
4 Washer
5 Frame end
6 Screw
7 Washer
8 Screw
9 Washer
10 Screw
11 Brush
12 Spring
13 Screw
14 Washer
15 Brushholder
16 Plate
17 Plate
18 Washer
19 Screw
20 Screw
21 Drive housing
22 Packing
23 Lever shaft
24 Packing
25 Washer
26 Clutch assembly
27 Plunger assembly
28 Screw
29 Washer
30 Lever housing
31 Armature
32 Washer
33 Bushing
34 Seal
35 Washer
36 Coil assembly
37 Insulation
38 Terminal stud assembly
39 Starter frame

d. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent.

(2) Inspect all parts for wear, defects, and damage. Replace worn, defective, or damaged parts.

(3) Inspect the bushings (33) and frame end (5) carefully. If worn so that play on the armature shaft exceeds 0.025—0.035 inches, replace the bushings. Apply thin coat of all-purpose grease to inside of bushings prior to reassembly of unit.

(4) Inspect the starter brushes (11) and check brush spring tension. Replace brushes if worn sufficiently to decrease spring tension appreciably.

(5) Inspect the armature commutator for pitted or burned bars and high insulation. Turn down the commutator and under cut the insulation as required.

NOTE

Burning and arcing of the commutator bars may be caused by open armature coils.

e. Testing. Prior to assembly, test the electrical components of the starter for short circuits, open circuits and grounds.

(1) Test the armature for short circuits by revolving in a growler. Hold a steel strip or hacksaw blade above each slot as the armature is rotated. Excessive vibration of the strip above a coil will indicate a short-circuited coil.

(2) Test the armature for grounds with a low wattage lamp (50-75 watts) connected in series with a 110-volt source and each commutator bar and the armature shaft.

(3) Test the field coils for open circuits with the same type of series circuit.

f. Assembly.

(1) Install the brush holders (15), springs, (12), screws (8 and 10) and the frame end (5). Install the brushes (11), and connect the leads to the brushes with screws (6).

(2) Install the armature (31), washer (32), bushing (33), seal (34), washer (35), coil assembly (36), and insulation (37) into the starter frame (39).

(3) Position the frame end (5) with brushes attached to the starter frame (39) being careful to lift the four brushes over the commutator. Secure the frame end to the starter frame with the three screws (3) and washers (4).

(4) Use a new packing and install the lever housing (30) with five screws (28) and washer (29) on the starter.

(5) Install clutch assembly (26), washer (25), packing (24) and lever shaft (23). With five mounting screws (19) and screw (20), secure the drive housing (21) using a new packing (22) to the lever housing (30).

(6) Install the plunger assembly (27), the solenoid (2) and the terminal stud assembly (38) to the starter frame (39).

g. Installation. Install the starting motor (TM 5-3810-233-12).

3-2. Engine Alternator

a. General.

(1) The battery-charging circuit consists of an engine-mounted, belt-driven alternator 28-volt with built-in voltage regulator, batteries, and wiring. A reverse voltage polarity relay is included in the circuit for additional protection. The alternator output is 60 amperes (can be easily changed to 40 amperes) at 28 volts. Alternating current rectification is provided by long-life silicon diodes, and voltage regulation can be adjusted externally with a conventional screwdriver.

(2) Before the alternator is disassembled for rebuild, all external circuit elements (belt tension, wiring and terminal connections, and condition of battery) should be carefully checked for proper performance before assuming that the alternator is malfunctioning.

b. Removal.

NOTE

Alternators received from supply will have only one (1) terminal post, with an ignition wire lead identified by a plug type connector. Remove the cover, cut off the plug connector and install an eye type connector. Attach this connector to the output terminal post of the alternator.

(1) Disconnect the battery leads (TM 5-3810-233-12).

(2) Loosen the mounting bolts and remove the drive belt (fig. 3-2).

(3) Disconnect the leads from the alternator.

(4) Remove the mounting bolts and the alternator.

CAUTION

Insulate the lead to the battery with a dry rag or other insulating material.

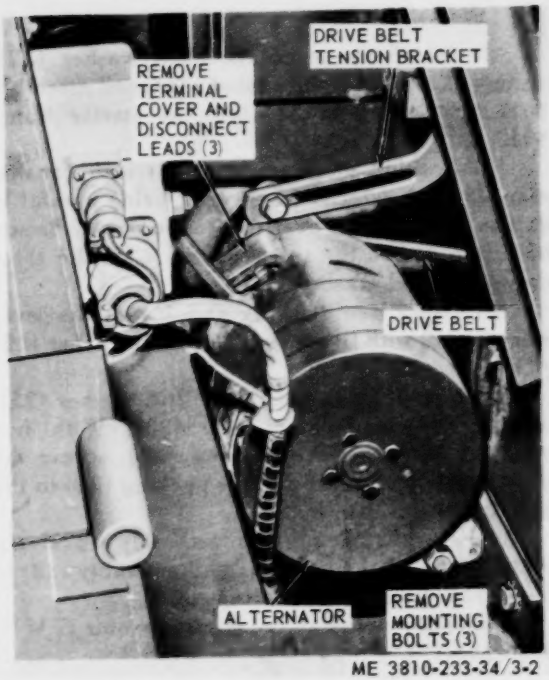


Figure 3-2. Alternator, removal and installation.

c. Disassembly.

(1) Remove pulley nut, guard washer, and pulley with suitable puller.

NOTE

Clamp pulley in vise with protective jaws when removing nut.

(2) Remove key and pulley spacer.

(3) Remove the six socket head screws (38, fig. 3-3).

(4) Remove drive end housing (29), regulator assembly (25), and packing (23).

(5) Remove the four screws (53) and regulator assembly (25) from the drive end housing (29).

NOTE

The regulator also serves as a bearing retainer and must be removed when replacing the drive end bearing (26).

(6) Remove the bearing (26), packing (27), and spacer (28) from the drive end housing (29).

(7) Remove the two screws (22), guard washers (21), and lockwashers (14) which secure the brush holder (20), and remove the brush holder. Remove the brushes (56) from the holder.

(8) Remove the screw (50), washer (49), and sleeve (48) from rotor shaft (41). Remove fan (47) and key (51) from shaft.

(9) Remove the six screws (52) and pull the end housing (45) and rotor assembly from the intermediate housing assembly (10).

(10) Remove the end housing (45) from the rotor shaft. Remove the bearing (44).

NOTE

The bearing may remain on the rotor shaft or in the housing. Removal procedure will be controlled by its location.

(11) Press the seal (39) out of the intermediate housing (10).

NOTE

Replace with new seal when assembling.

(12) Further disassembly of the unit is not required unless tests listed in paragraph *e* below indicate a defective component.

Key to figure 3-3:

1 Rectifier
2 Rectifier
3 Bushing
4 Insulator
5 Washer
6 Washer
7 Lockwasher
8 Screw
9 Rectifier
10 Intermediate housing assembly
11 Gasket
12 Capacitor and lead assembly
13 Clamp
14 Lockwasher
15 Screw
16 Screw
17 Cover
18 Screw
19 Pin
20 Holder
21 Washer
22 Screw
23 Preformed packing
24 Nut
25 Regulator assembly
26 Bearing
27 Preformed packing
28 Spacer
29 Drive end housing
30 Plug
31 Gasket
32 Cover
33 Lockwasher
34 Screw
35 Spacer
36 Washer
37 Nut
38 Socket hd. screw
39 Seal
40 Seal
41 Rotor assembly
42 Stator assembly
43 Preformed packing
44 Bearing
45 End housing
46 Preformed packing
47 Fan and hub assembly
48 Seal sleeve
49 Washer
50 Screw
51 Key
52 Screw
53 Screw
54 Screw
55 Connector, socket
56 Brush
57 Rectifier
58 Stud
59 Screw
60 Insulator
61 Nut

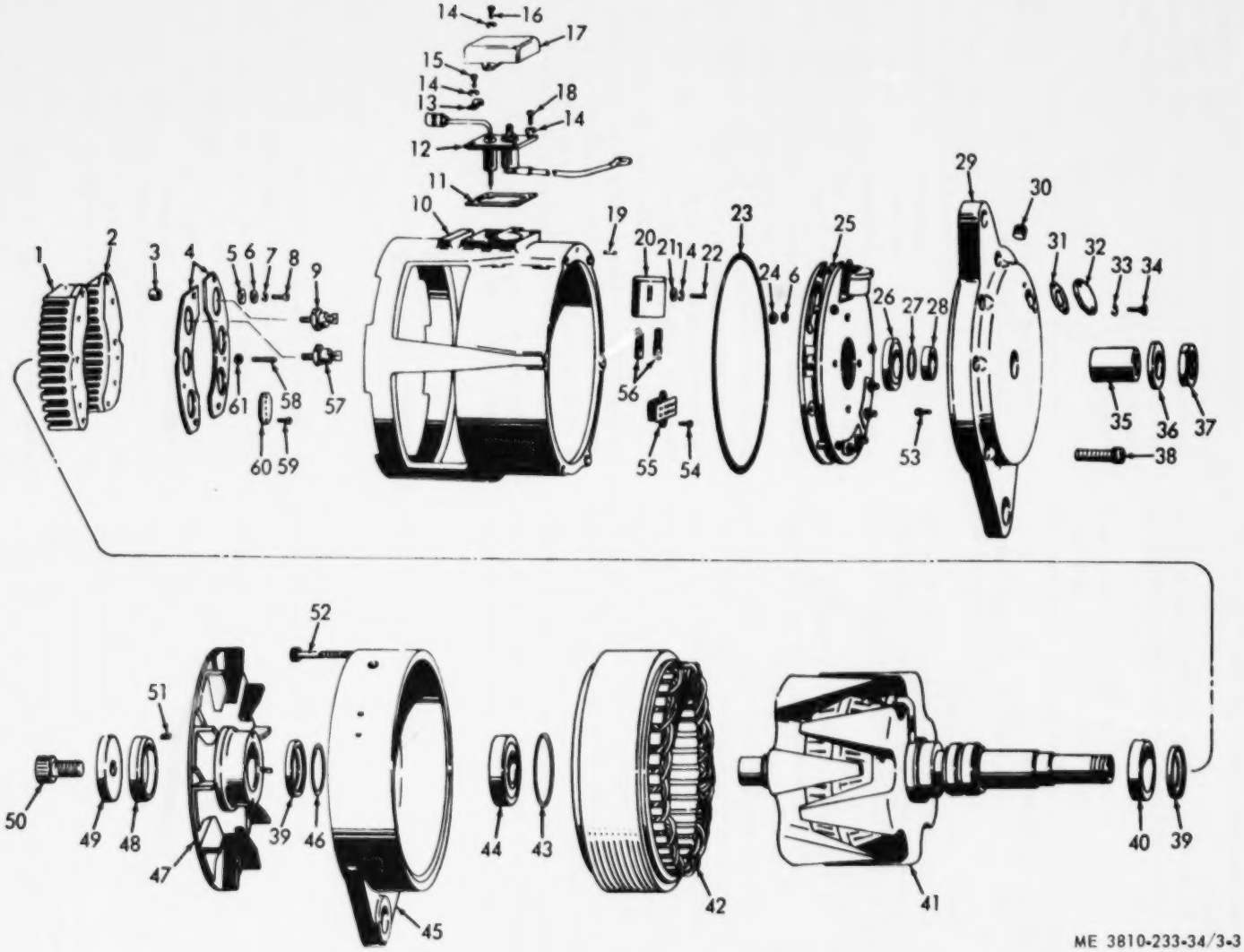


Figure 3-3. Alternator, exploded view.

d. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly with low-pressure compressed air.

NOTE

Do not immerse electrical components in solvent. Wipe as clean as possible with dampened cloth.

(2) Inspect bearings (26 and 44) for wear. If total radial clearance of either exceeds 0.0025 inch, replace the bearing(s).

e. Testing.

(1) Slide the three insulating sleeves away from the splices and unsolder the connections to the stator leads.

(2) Connect a series test light between each stator lead and the core. Lighting of the test lamp indicates a grounded coil which will necessitate the replacement of the stator.

(3) Connect the test lamp between each stator lead for a continuity check. An open circuit will require replacement of the stator.

(4) The positive heat sink is insulated from the housing. A continuity check with test lamp or ohm meter will indicate the need for replacing insulators and bushings.

(5) The negative heat sink is grounded to the housing through its mounting screws. All connections must be clean and secure.

(6) Test the positive diodes by connecting the negative lead of an ohm meter to check point 2 (C, fig. 3-4) and the positive lead to terminals 1, 2, and 3. A low resistance reading should be obtained. Reverse the ohm meter leads. A high resistance reading should be obtained. *If a low resistance reading is obtained, the diode is short circuited and must be replaced.*

(7) Check the diodes in the negative heat sink by connecting the negative test lead of an ohm meter to check point 1 and touching the positive lead to terminals 4, 5, and 6 (C, fig. 3-4). A low reading indicates a defective diode and consequent replacement.

(8) In case the above electrical components check out satisfactorily, replace the voltage regulator assembly (25, fig. 3-3).

NOTE

Do not attempt to repair the voltage regulator assembly.

(9) To replace a defective diode, unsolder the lead and remove the rubber sealant from around the diode. Unscrew the diode; check the mounting surface of the heat sink for burrs or foreign material which might prevent the new diode from seating properly.

CAUTION

Observe the correct polarity when replacing diodes. Otherwise, serious damage will result.

(10) *Insert the new diode and tighten to a torque of 20-25 inch pounds.* Resolder the lead to the diode, avoiding excessive heat when soldering.

(11) When necessary to replace stator assembly, unsolder the leads and cut the leads as close as possible on both sides of the intermediate housing (10, fig. 3-3). Remove the stator assembly (42) from the intermediate housing (10).

(12) Carefully remove the sealant (epoxy) which seals the three leads into the housing. Insert the new stator assembly in the housing and reinstall the fiber insulator and screws. Fill the area around the leads with new sealant.

f. Assembly. Assemble the alternator in the reverse order of disassembly. Use the special tool (para 2-1, fig. 2-1) when installing the rotor (41, fig. 3-3) to avoid damage to the seal (40).

CAUTION

Before assembling lip seal, lubricate as illustrated (B, fig. 3-4).

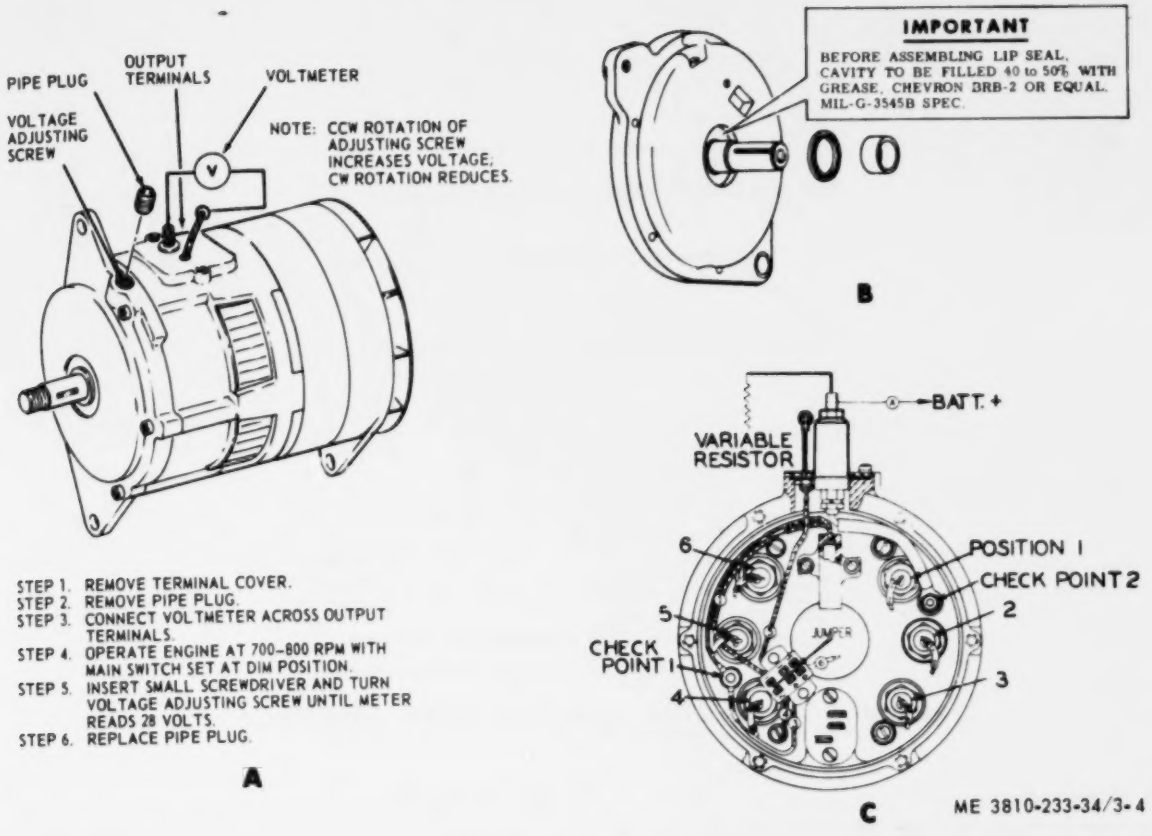

PIPE PLUG
OUTPUT TERMINALS
VOLTMETER
VOLTAGE ADJUSTING SCREW
NOTE: CCW ROTATION OF ADJUSTING SCREW INCREASES VOLTAGE; CW ROTATION REDUCES.
STEP 1. REMOVE TERMINAL COVER.
STEP 2. REMOVE PIPE PLUG.
STEP 3. CONNECT VOLTMETER ACROSS OUTPUT TERMINALS.
STEP 4. OPERATE ENGINE AT 700–800 RPM WITH MAIN SWITCH SET AT DIM POSITION.
STEP 5. INSERT SMALL SCREWDRIVER AND TURN VOLTAGE ADJUSTING SCREW UNTIL METER READS 28 VOLTS.
STEP 6. REPLACE PIPE PLUG.
A
IMPORTANT
BEFORE ASSEMBLING LIP SEAL, CAVITY TO BE FILLED 40 to 50% WITH GREASE, CHEVRON SRB-2 OR EQUAL. MIL-G-3545B SPEC.
B
BATT. +
VARIABLE RESISTOR
POSITION 1
CHECK POINT 2
CHECK POINT 1
JUMPER
2
3
4
5
6
C
ME 3810-233-34/3-4

Figure 3-4. Alternator data.

g. Installation.

(1) Install the alternator in reverse order of removal.

(2) Adjust the drive belt for correct tension (TM 5-3810-233-12).

h. Adjustment. Refer to figure 3-4A and adjust the alternator.

Section II. ROCKER COVER ASSEMBLY

3-3. General

The rocker cover assembly completely encloses the valve and rocker arm compartment at the top of the cylinder head. The top of the cylinder head is sealed against oil leakage by a gasket located in the flanged edge of the rocker cover. An option equipment plate is attached to the cover, and contains in addition to the identifying type numbers of the accessory and optional equipment on the engine, the unit model and serial number.

3-4. Removal

a. Wipe the cover (1, fig. 3-5) clean before removing it from the engine.

b. Loosen the bolts (3) and remove the cover.

3-5. Cleaning and Inspection

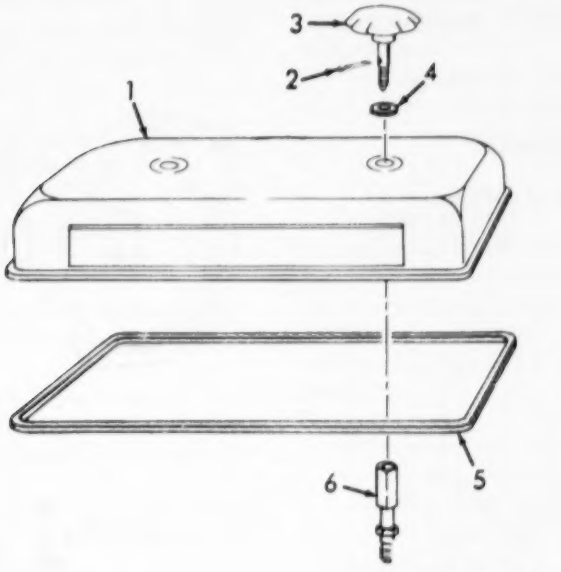
a. Clean the cover with an approved cleaning solvent. Dry thoroughly.

b. Inspect the cover and gasket (5) for cracks or breaks. Replace as required.

c. Inspect the studs (6) to make sure they are solidly seated in the cylinder head.

3-6. Installation

Seat the cover evenly on the cylinder head, making sure the flanged edges clear the edges of the cylinder head. Tighten the bolts alternately until both are securely fastened.



ME 3810-233-34/3-5

1 Cover
2 Pin
3 Bolt
4 Washer
5 Gasket
6 Stud

Figure 3-5. Rocker cover assembly, exploded view.

Section III. INJECTOR CONTROL TUBE ASSEMBLY

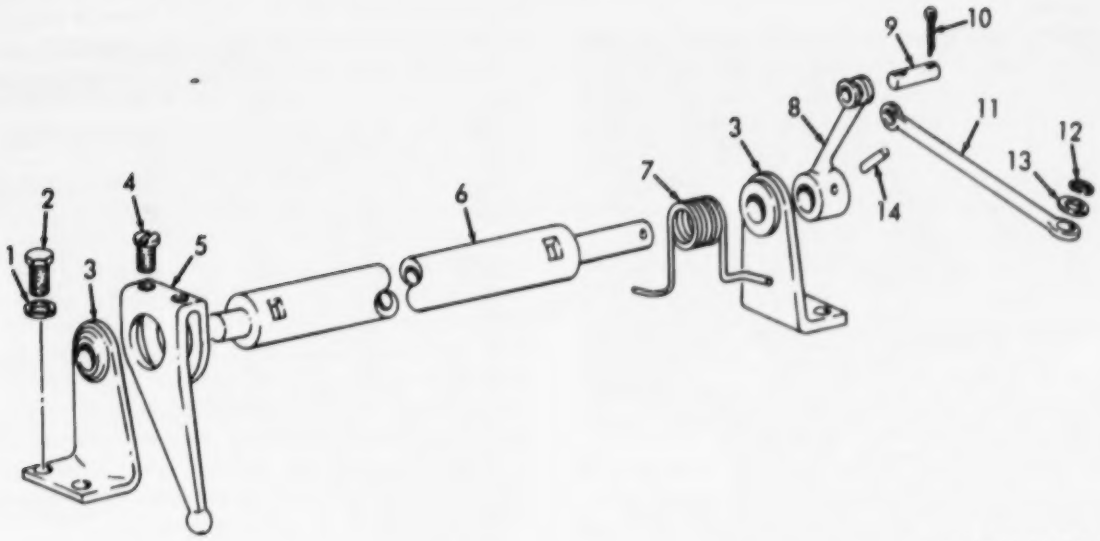
3-7. General

The injector control tube assembly is mounted to the top of the cylinder head. It is connected through a lever and clevis to the linkage of the limiting speed governor and controls the amount of fuel injection into the combustion chambers. The control levers, mounted on the control tube, are adjustable and are used to control the quantity of fuel metered into each individual cylinder of the engine.

3-8. Removal

a. Remove the cotter pins (10, fig. 3-6) and pin (9) from the actuating arm (8). Remove the fuel rod (11) from the arm.

b. Remove the four capscrews (2) and lockwashers (1) that secure the injector control tube assembly brackets (3) to the cylinder head. Slide the injector control tube assembly toward the rear of the engine to disengage the injector control levers from the control racks of the injectors and remove the injector control tube.



1 Lockwasher
2 Capscrew
3 Bracket
4 Screw
5 Control lever
6 Injector control tube
7 Spring
8 Actuating arm
9 Pin
10 Cotter pin
11 Fuel rod
12 Retainer
13 Washer
14 Pin

Figure 3-6. Injector control tube assembly, exploded view.

3-9. Disassembly

a. Remove the control tube bracket (3) from the control tube.

b. Drive the pin (14) from the injector tube actuating arm (8) and injector control tube (6) and remove the injector tube actuating arm.

c. Disengage the spring (7) from the control tube bracket (3) and remove the control tube bracket from the injector control tube (6).

d. Remove the spring from the injector control tube after disengaging from the control lever.

e. Remove the 2 screws (4) that secure the control lever (5) to the injector control tube (6) and remove the control lever off the end of the tube. Remove the 2 remaining control levers in the same manner.

3-10. Cleaning, Inspection, and Repair

a. Clean all parts with an approved cleaning solvent and wipe dry with a clean cloth.

b. Examine all parts for cracks, breaks, and excessive wear. Replace a defective part.

c. Test the tension of the spring while installed to see that it has sufficient strength to return the injector control tube to the OFF position. Replace a weak spring.

d. Inspect all hardware for damaged threads or fatigue. Replace all damaged hardware.

3-11. Assembly

a. Slide the control lever (5) over the end of the injector control tube (6) and into position over the cutaway portion of the control tube. Secure the control lever in place with the two screws (4). Install the two remaining control levers in the same manner.

b. Position the spring (7) over the end of the injector control tube (6) and hook one spring loop over the forward control lever.

c. Install the control tube bracket (3) over the injector control tube (6).

d. Position the injector tube actuating arm (8) on the injector control tube (6). Aline the pin mounting hole and install the pin (14) through the actuating arm and lever.

e. Install the control tube bracket (3) on the other end of the control tube.

3-12. Installation

a. Position the injector control tube assembly on the cylinder head and secure with the four screws (2) and lockwashers (1). Hook one loop of the spring around the control tube bracket. Make sure the control levers (5) properly engate the slots in the fuel injector control racks.

b. Push the injector control tube to the full ON position to assure that the spring pulls the injector

racks to the full OFF position when the control tube is released.

c. If any bind exists in the injector control tube assembly, loosen the control tube brackets and shift the injector control tube assembly slightly to remove all bind. Tighten the mounting screws.

CAUTION

The injector control tube assembly must return to the OFF position freely by the action of the spring only. Do not bend the spring to bring about this condition.

3-13. Positioning Control Levers

NOTE

The control lever (5) adjusting screws (4) are referred to as the inner and outer adjusting screws with the inner screws being nearest the injectors.

a. Loosen the inner adjusting screw (4) and outer adjusting screw (4) to free all control levers (5).

b. Hold the fuel injector racks in the full fuel position, all the way in towards the rocker arms assembly.

NOTE

Adjust the number one control lever, the one closest to the spring first, to establish a guide for adjusting the remaining control levers.

c. Tighten the inner adjusting screw (4) until a slight movement in the control lever is observed, then tighten the outer adjusting screw (4).

d. With the injector control tube assembly in the full fuel position, check for a slight horizontal movement of the injector tube actuating arm (8). The movement should not exceed 0.005 inch.

e. If no movement is observed, back off the inner adjusting screw (1) one-eighth of a turn and tighten the outer adjusting screw. If the horizontal movement of the injector tube actuating arm exceeds 0.005 inch, back off the adjusting screw one-eighth turn and tighten the inner adjusting screw.

f. With the fuel injector rack of No. 1 injector held tight against the control lever, place a finger on the injector rack of No. 2 injector. Tighten the inner adjusting screw until the control lever starts to tighten against the injector rack. Then tighten the outer adjusting screw. Adjust the remaining control lever in the same manner.

g. Install the fuel rod (11) and pin (9) in the actuator arm (8). Replace the cotter pin (10). Replace in the rocker cover.

Section IV. FUEL INJECTOR ASSEMBLY

3-14. General

The fuel injector performs a quadruple duty. Its consturction combines a fuel filter, fuel pump and spray tip in a single unit to properly supply each cylinder with fuel. Because of its multiple construction, the injector assembly filters, meters, pressurizes and atomizes the fuel during injection into each cylinder. The fuel is supplied to the injectors by the fuel pump through the fuel inlet manifold. Excess fuel passes through the injector and is returned through outlet manifold to the fuel tank. The continuous bypass of fuel through the injector eliminates air pockets and acts as a coolant. The fuel injectors are located on top of the cylinder head and are operated by a separate rocker arm that is driven indirectly by the engine camshaft.

3-15. Removal

CAUTION

Cover each fuel fitting on the injector with a shipping cap or other suitable cover after removing the fuel lines to prevent dirt from entering the injector. Also, cover the injector hole in the cylinder head after removing the injector.

a. Remove the rocker cover.

b. Disconnect the fuel lines from the injector and fuel connectors (fig. 3-7).

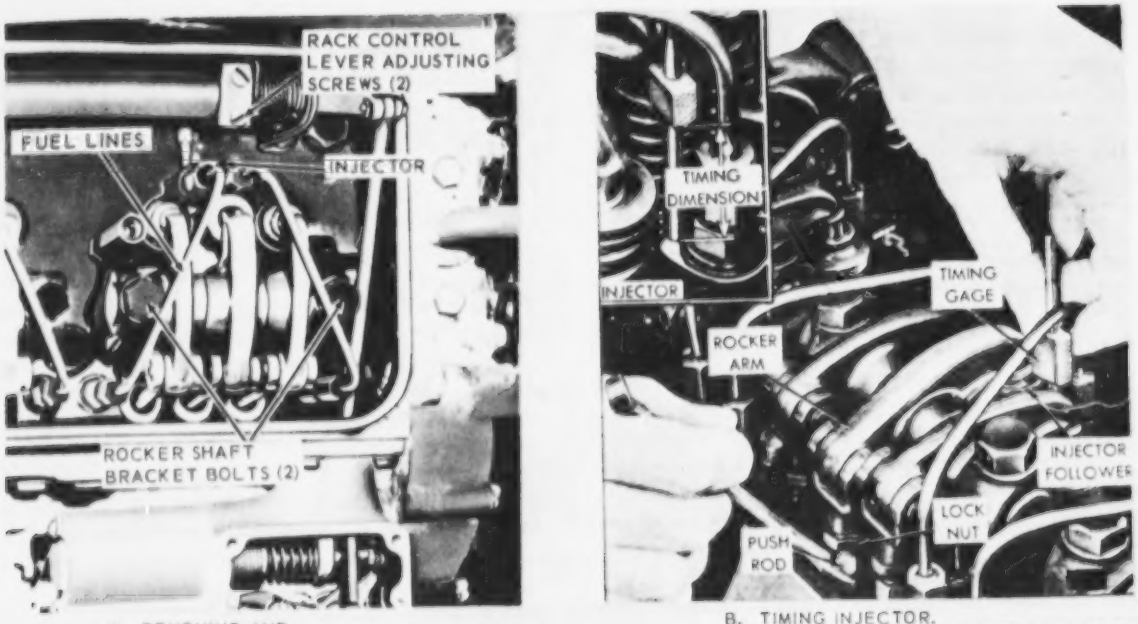
c. Turn the crankshaft manually in a clockwise direction, or rotate the engine with the starting motor, until the rocker arms for the particular cylinder are alined in a horizontal plane.

d. Remove the two shaft bracket bolts and swing the rocker arm assembly away from the injector and valves.

e. Remove the injector clamp bolt washer and clamp (1, 2, 3, fig. 3-8). Loosen the inner and outer adjusting screws on the injector rack control lever and slide the lever away from the injector.

f. Free the injector from its seat (fig. 3-7) and lift the injector from the cylinder head.

g. Cover the injector hole in the cylinder head to prevent the entry of dirt or foreign matter.



A. REMOVING AND INSTALLING INJECTOR.

B. TIMING INJECTOR.

MF 3810-233-34/3-7

Figure 3-7. Fuel injector, removal and installation.

3-16. Disassembly

a. Place the injector assembly in a holding fixture in an upright position. Remove the filter injector caps (7, fig. 3-8) and gaskets (8).

b. Remove the helical compression spring (9) and fuel injector filter element (10) from the recess in the injector body assembly (13).

c. Compress the follower helical compression spring (6), then, using a screwdriver, raise the spring above the stop pin (28) and remove the pin. Allow the plunger spring to extend gradually.

d. Remove the plunger lifter (4), plunger (5), and spring (6) from the injector body assembly as an assembly, and separate each part.

e. Invert the injector in the holding fixture and remove the fuel injector retaining nut (19) from the injector body assembly.

CAUTION

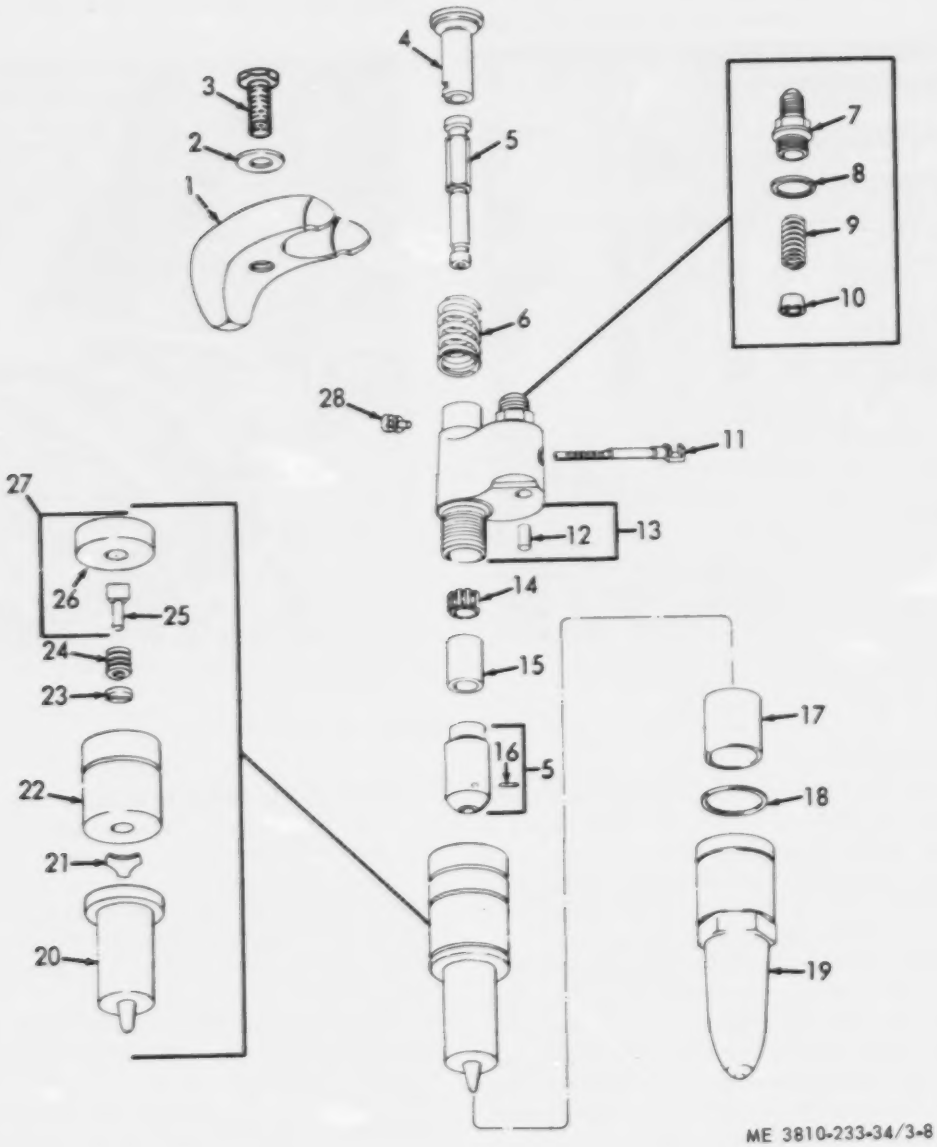
Lift the injector retaining nut straight up by hand, being careful not to dislodge the spray tip and valve parts.

f. Lift the spray tip (20), valve (21), injection valve cage (22), stop (23), helical compression spring (24), injector valve (25), and injector valve seat (26) from the plunger and bushing assembly (5).

g. Remove the dirt and liquid deflector (17) and preformed packing (18) from the fuel injector retaining nut (19).

h. Remove the plunger and bushing assembly (5), injector gear retainer (15), and spur gear (14) from the injector body assembly.

i. Remove the control rack (11) and straight headless pin (12) from the injector body assembly.



1 Clamp
2 Washer
3 Screw
4 Follower
5 Plunger and bushing assembly
6 Spring
7 Cap
8 Gasket
9 Spring
10 Filter element
11 Rack
12 Pin
13 Body
14 Gear
15 Gear retainer
16 Pin
17 Deflector
18 Packing
19 Nut
20 Tip
21 Valve
22 Cage
23 Stop
24 Spring
25 Valve
26 Seat
27 Valve assembly
28 Pin

Figure 3-8. Fuel injector assembly, exploded view.

3-17. Cleaning, Inspection, and Repair

a. Discard the filter-element. Clean all injector parts with an approved cleaning solvent and dry with filtered compressed air.

b. Inspect the packing surface of the injector body for burrs or scratches. Inspect the injector body for cracks, breaks, or damaged parts. Replace a damaged injector body.

c. Inspect the spray tip, disk, injector valve cage, spray tip valve, injector valve seat, plunger, and bushing assembly, and bushing surface of the injector body with a magnifying glass for scoring or other damage. These parts of the injector have a lapped finish and if any of the parts are damaged, new parts must be installed.

d. Inspect the teeth on the control rack and spur gear for excessive wear or damage. Replace the gear and rack if damaged.

e. Inspect the spray tip orifices, plunger and bushing assembly, and rack opening in the injector body with a suitable tool.

f. Before installing used valve parts, all sealing surfaces must be lapped, with the exception of the slot in the injector valve seat. If new valve parts are installed, lightly lap the sealing surfaces.

g. To inspect the plunger and the plunger bushing, install the plunger bushing on the plunger and revolve. The bushing must spin freely on the plunger. The plunger bushing and plunger are matched parts. They must be considered as one piece and, if one must be replaced, both must be replaced.

CAUTION

Do not handle the plunger excessively as perspiration may cause rust and sticking in the plunger bushing. Immerse injector parts frequently in clean fuel oil to prevent this.

3-18. Assembly

a. Dip each part of the injector body assembly in clean fuel oil immediately before it is assembled.

b. Hold the injector body assembly (13) upright and assemble new fuel injector filter elements (10) in each of the cavities of the injector body. Place a helical compression spring (9) above each filter element and a new gasket (8) against the shoulder of each filter injector cap (7); lubricate the threads of the filter injector caps and tighten to the filter body to 65 to 75 ft-lb torque.

NOTE

When assembling the filter elements, always position the dimple at the bottom of the fuel opening.

c. With the injector inverted, slide the control rack (11) through the hole in the body so the two marked teeth are visible. The two teeth of the control rack are match marked with the spur gear (14). For the correct timing, position the marked tooth of the gear between the two marked teeth on the rack.

d. Position the injector gear retainer (15) down on top of the spur gear (14) and the plunger and bushing assembly (5) down onto the retainer, with the locating pin in the bushing guided into the slot of the injector body. Slide the dirt and liquid deflector (17) into the fuel injector retaining nut (19) and the preformed packing (18) on the injector body.

e. Support the injector body in a holding fixture, valve end up. Place the injector valve seat (26) on the end of the plunger and bushing assembly (5). Insert the stem of the injector valve (25) in one end of the helical compression spring (24) and stop (23) in the opposite end of the valve spring. Lower the injection valve cage (22) and position the valve cage on the valve seat.

f. Centrally locate the valve (21) on the cage (22) and place the spray tip (20) over the valve and against the cage.

g. Lubricate the thread of the fuel injector retaining nut (19) and pilot the nut over the spray tip. The spray tip will slide through the hole in the small end of the retaining nut.

h. Screw the retaining nut (19) in place by hand, making sure that the valve assembly does not shift. Do not tighten the nut.

i Slide the head of the plunger (5) into the plunger lifter (4) and insert the plunger through the helical compression spring (6).

j. Invert the position of the injector in the holding fixture, filter injector cap up, and push the control rack (11) all the way in; insert the free end of the plunger (5) into the top of the injector body assembly (13).

k. Start the stop pin (28) into position in the injector body so that the bottom coil of the helical compression spring (6) rests on the narrow flange on the stop pin. Then, with the slot in the plunger lifter (4) and the hole in the injector body in alinement for the stop pin and flat side of the plunger positioned to engage the flattened side of the spur gear, press down on the top of the plunger lifter and at the same time press the follower stop pin into position. The stop pin will slip into position as soon as the slot in the followers and hole in the injector body come in alinement. When in place, the spring will hold the stop pin in position.

l. Invert the fuel injector assembly in the holding fixture and tighten the fuel injector retaining nut to 55 to 65 ft—lb torque.

m. Install the straight headless pin (12) into the injector body assembly.

3-19. Testing

a. Spray Tip Runout.

(1) Position the injector in a concentricity gage for checking spray tip runout.

(2) Turn the injector in a complete circle and check the total runout. The runout must not exceed 0.008 inch. If the runout exceeds 0.009 inch, loosen the fuel injector retaining nut (19) and center the spray tip (20). Retighten the nut. Repeat the procedure to obtain the correct runout. If the spray tip cannot be position satisfactorily, reinspect the injector assembly.

b. Rack Freedom.

(1) Hold the injector at both ends in a horizontal position with the plain end of the control rack (11) pointing downward. Turn the injector about its longitudinal axis until the rack coupling end points down. The injector rack should move through its full travel by its own weight when the injector is turned.

(2) If the control rack (11) does not fall freely, loosen the fuel injector retaining nut (19) and turn the spray tip (20) slightly. Tighten the fuel injector retaining nut and again check for rack freedom. If the rack still binds, disassemble the injector for inspection. Be sure to clean before reassembling and testing.

c. Plunger Binding.

(1) Install the injector, spring side up, in a holding fixture.

(2) Depress the plunger (5) and release it, noting the action of the plunger on the return stroke.

(3) Perform the test with the control rack (11) in 3 different positions; in the full-fuel position, in the no-fuel position, and midway between these two positions.

(4) If the plunger (5) sticks or binds, disassemble the injector, then reinspect, reassemble and retest.

d. Spray Tip Orifice.

(1) Position the injector in a test fixture with the dowel on the under side of the injector body, located in the hole of the fixture.

(2) Connect a fuel supply line from a test pump to the fuel-inlet side of the injector, and fuel return lines between the fuel outlet side of the injector and the fixture release valve.

(3) Fill the test pump with an approved fuel oil. Operate the pump handle to force all the air from the injector. Close the release valve and place a suitable container at the injector spray tip.

WARNING

When testing the injector, a container must always be positioned around the spray tip before an injector is popped. The high pressure fuel spray of the injector has sufficient penetrating power to cause serious injury to personnel.

(4) Operate the test pump handle a few times to check the fuel supply and return lines for leaks.

(5) With the injector rack in full fuel position, operate the pump handle to maintain a fuel pressure of 15 psi. Pop the injector several times with the fixture popping handle and observe the spray pattern emerging from the spray tip orifices. Fuel should be discharged from each orifice, and the spray from the orifices should form a uniform pattern.

e. Valve Opening Pressure.

(1) Operate the pump handle up and down with smooth, even strokes; noting the pressure on the pressure gage when the injector sprouts fuel. This pressure should be from 350 to 850 psi.

NOTE

Valve opening pressure should not be confused with actual injection pressure; because after the valve opens the fuel pressure continues to rise until injection is completed.

(2) If the valve opens at pressure lower than 350 psi, it indicates either a defective or dirty sealing surface or a defective or worn valve spring. In this event, remove the injector nut and clean, inspect, repair, and reassemble the valve parts.

f. Holding Pressure.

(1) Operate the pump handle to bring pressure to just below the injector pop or valve opening pressure.

(2) Close the pump valve and observe the pressure drop on the gage.

(3) Check the time required for the pressure to drop from 350 to 150 psi. This time should not exceed 50 seconds on a new injector, or 35 seconds on a used injector.

(4) If the drop exceeds these limits, locate the leak. Thoroughly dry the injector by blowing off all excess fuel oil with compressed air. Excessive clearance between the plunger and bushing or defective bushing-to-body fit is indicated by a leak at the rack opening in the injector body. A loose injector nut will cause a leak around the spray tip or seal ring. Faulty sealing surfaces in the valve parts will be indicated by a dribble or drop at the spray tip orifice. Leaks around the fuel connections or body plugs can be corrected by tightening or replacing defective parts.

3-20. Installation

a. Before installing a fuel injector assembly, be sure the beveled seat of the injector tube is free from dirt and carbon deposits.

b. Position the injector assembly in the injector tube with the locating pin registering with the locating hole in the cylinder head, and with the pin on the injector control rack.

c. Install the injector in the cylinder head as shown in figure 3-7.

d. Reposition the injector rack control lever and tighten the adjusting screws.

e. Replace the injector clamp; washer and capscrew.

CAUTION

Use a torque wrench to tighten the clamp capscrew. Do not exceed 25 ft-lbs torque. Overtightening may cause the injector rack to bind and result in uneven running of the engine.

f. Replace the rocker shaft bracket bolts. Tighten to 90-100 ft-lbs. torque.

g. Adjust exhaust exhaust valves (para 3-25 *d*).

h. Replace the fuel lines. Tighten the fuel line nuts to 144-180 in-lbs. torque.

3-21. Injector Timing and Governor Adjustment

a. General. To time an injector, the injector follower must be adjusted to a definite height in relation to the injector body. The injectors can be timed, in firing order sequence, during one full revolution of the crankshaft. The firing order of this model engine is 1-3-2. The crankshaft may be rotated with the starter, or by barring manually on the roller chain drive hub at the crane hydraulic pump.

b. Fuel Injector Replacement. The replacement of fuel injectors has been covered previously in paragraph 3-15.

c. Timing Fuel Injectors.

(1) Place the governor stop lever in the NO-FUEL position.

(2) Rotate the crankshaft until the exhaust valves on the particular cylinder are fully depressed.

(3) Place the small end of the injector timing gage in the hole provided in the top of the injector body, with the flat of the gage toward the injector follower (fig. 3-7).

(4) Loosen push rod nut.

(5) Turn the push rod and adjust the injector rocker arm until the extended part of the gage just clears the top of the injector follower.

(6) Hold the push rod and tighten the lock nut. Recheck with the gage, and if necessary, readjust the push rod.

(7) Time the remaining injectors in the same manner.

d. Adjusting Governor Gap. With the engine at operating temperature; adjust the governor gap as follows:

(1) Remove two screws and high speed spring retainer cover.

(2) Back out the buffer screw until it extends ⅝ inch from the locknut.

(3) Start engine. Loosen idle screw locknut and adjust engine idling speed to 450 rpm.

(4) Stop engine. Remove rocker cover, governor cover and fuel rod.

(5) Start engine and run at 800-1000 rpm by manual operation of injector tube control lever (fig. 3-9).

CAUTION

Do not overspeed engine.

(6) Insert 0.0015 inch feeler gage between low speed spring cap and high speed plunger (fig. 3-9).

(7) If gap is incorrect, loosen locknut and adjust the gap adjusting screw until feeler gage insertion feels firm.

(8) Hold adjusting screw and tighten locknut.

(9) Recheck the governor gap, with the engine operating at 800-1000 rpm, by placing a screwdriver between the adjusting screw and governor housing and manually forcing the gap closed.

Figure 3-9. Injector timing and governor adjustment.

NOTE

Place a drop of oil on the gap just before closing which will make the closing easily seen.

(10) Stop the engine. Replace the fuel rod, governor cover and lever assembly.

e. Positioning Injector Rack Control Levers. The position of the injector racks must be correctly set in relation to the governor. Adjust the No. 1 rack control lever first to use as a guide in adjusting the remaining rack control levers.

(1) Disconnect any linkage attached to the governor speed control lever.

(2) Loosen the idle speed adjusting screw locknut. Back out the adjusting screw until ½ inch of the threads project from the locknut when the nut is against the high speed plunger.

(3) Loosen all inner and outer rack control lever adjusting screws.

NOTE

Make sure that all control levers are free on the injector control tube.

(4) Move the governor speed control lever to the maximum speed position (fig. 3-9). Hold the lever in that position.

(5) Turn the inner adjusting screw until a slight movement of the control tube is observed. Turn the outer adjusting screw until it bottoms lightly on the control tube.

(6) Alternately tighten the inner and outer adjusting screws.

(7) Check the adjustment by holding the speed control lever in its maximum position and pressing down on the injector rack, causing the rack to rotate.

NOTE

The setting is correct if the rack returns to its original position. If it does not return, loosen the outer screw slightly and tighten the inner screw slightly. If the setting is too tight, moving the speed control lever from idle to maximum speed position will cause the injector rack to tighten before the speed control lever reaches its maximum position. Correct by backing off inner screw lightly and tightening outer screw slightly.

(8) Manually hold the No. 1 injector in the full-fuel position and turn the inner adjusting screw of the No. 2 injector until the injector rack has moved into the full-fuel position and the screw is bottomed on the injector control tube.

(9) Turn the outer adjusting screw until it bottoms lightly on the control tube. Alternately tighten both screws.

(10) Position the remaining rack control lever as outlined above.

(11) Connect the fuel rod to the injector tube control lever.

(12) Reset the idle speed screw until it projects ⅜ inch beyond locknut. Tighten locknut.

(13) Replace linkage and rocker cover.

f. Adjusting Maximum No-Load Speed. Governors are normally adjusted before leaving the factory. However, if the governor has been replaced, the maximum no-load speed (2,300 rpm) may require setting.

(1) Remove high speed spring retainer cover.

(2) Loosen the locknut, and back off the high speed spring retainer approximately five turns (fig. 3-9).

(3) With the engine at normal operating temperature and no-load on the engine, place the governor speed control lever in the full-fuel position.

(4) Turn the high speed spring retainer in until the instrument panel tachometer reads 2,300 rpm.

NOTE

If the accuracy of the crane tachometer is doubted, check the speed with an accurate hand tachometer.

(5) Hold the spring retainer and tighten the lock nut.

(6) Replace cover.

g. Adjusting Idle Speed. With the engine at normal operating temperature and the maximum no-load speed properly adjusted, adjust the idle speed to 450 rpm.

(1) Remove the high speed spring retainer cover.

(2) Back out the buffer screw to avoid contact with the differential lever.

(3) Loosen locknut and turn idle speed adjusting screw until recommended speed is attained.

(4) Tighten locknut while holding screw in position.

(5) Replace high speed spring retainer cover.

h. Adjusting Buffer Screw. With the engine at normal operating temperature, and after adjusting the idle speed, adjust the buffer screw.

(1) Turn the buffer screw in sufficiently to contact the differential lever lightly without causing the engine to roll (fig. 3-9).

(2) Hold the buffer screw and tighten the locknut.

Section V. CYLINDER HEAD ASSEMBLY

3-22. General

The cylinder head is a one-piece casting secured to the cylinder block by studs, nuts, and bolts. The head can be removed as an assembly containing the cam followers and guides, push rods, rocker arms, exhaust valves, and injectors. The fuel inlet and

outlet manifolds are cast as an integral part of the head. Spray nozzles pressed into the water inlet ports insure better cooling of the sections and components of the head subjected to the greatest heat. Service operations on the engine which require the removal of the cylinder head are:

a. Remove and install pistons.
b. Remove and install cylinder sleeves.
c. Remove and install exhaust valves.
d. Remove and install valve guides.
e. Recondition valves and replace valves seat inserts.
f. Replace injector tubes.
g. Remove and install camshaft.
h. Install new cylinder head gaskets.

3-23. Cylinder Head Assembly

a. Removal.

(1) Remove the rocker arm cover (para 3-4).

(2) Drain the cooling system (TM 5-3810-233-12).

(3) Remove the air compressor (TM 5-3810-233-12).

(4) Remove the water manifold (TM 5-3810-233-12).

(5) Remove the exhaust manifold (TM 5-3810-233-12).

(6) Disconnect the throttle control linkage to the governor. Remove the governor housing cap and remove the governor fuel rod (para 3-44).

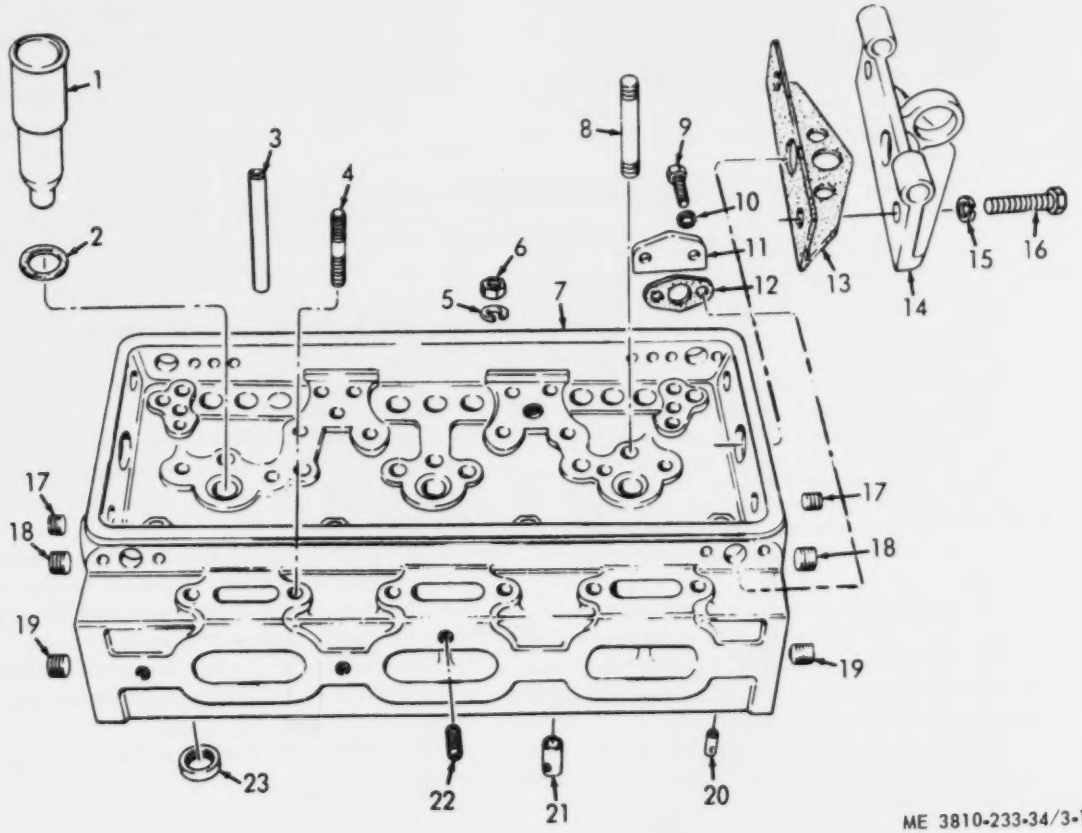
(7) Remove the governor-to-cylinder head attaching bolts and lockwashers.

(8) Disconnect the fuel lines to the fuel strainer and filter and remove the filter units (TM 5-3810-233-12).

(9) Remove four stud nuts and four bolts which secure cylinder.

(10) Remove the capscrews and lockwashers which attach the lifting brackets (14, fig. 3-10) to the balance weight cover and flywheel housing.

(11) Insert the lifting hooks in the eyes of the lifting brackets and lift the cylinder head evenly off the cylinder block studs.



ME 3810-233-34/3-10

1 Injector hole tube
2 Preformed packing
3 Valve guide
4 Stud
5 Lockwasher
6 Nut
7 Cylinder head
8 Stud
9 Capscrew
10 Lockwasher
11 Cover
12 Gasket
13 Gasket
14 Lifting bracket
15 Lockwasher
16 Capscrew
17 Plug
18 Plug
19 Plug
20 Nozzle
21 Nozzle
22 Plug
23 Valve seat insert

Figure 3-10. Cylinder head assembly, exploded view.

b. Disassembly.

(1) Set the head on its side and remove the capscrews (16), lockwashers (15), lifting brackets (14), and gaskets (13).

(2) Remove the injector control tube assembly (para 3-8).

(3) Remove the rocker arm assemblies (para 3-24).

(4) Remove the fuel injectors (para 3-15).

(5) Remove the exhaust valves (para 3-25).

CAUTION

Support the bottom of the cylinder head on wooden blocks when placing the head on the workbench. Otherwise, parts projecting below the bottom of the head may be damaged.

(6) Remove the valve guides (3).

(7) Remove the valve seat inserts (23).

(8) Remove the capscrews (9), lockwashers (10), covers (11), and gaskets (12) from the cylinder head.

(9) Remove the pipe plugs (17, 18, 19, and 22) from the sides and end of the cylinder head.

(10) Remove the injector hole tubes (1) and packing (2).

(11) Remove the water outlet nozzles (20 and 21).

c. Cleaning.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly with compressed air.

(2) Remove all carbon deposits from the cylinder combustion chambers.

(3) Place the cylinder head casting in a bath of cleaning solvent and agitate thoroughly to remove all scale and grease. Dry thoroughly with compressed air.

(4) Dip the cleaned head casting in a rust preventive bath to prevent rusting.

d. Inspection and Repair.

(1) *Warpage.* Check the warpage (flatness) of the cylinder head fire dock (bottom) with an accurate, heavy straight-edge and feeler gage. The maximum longitudinal warpage is 0.0055 inch and maximum transverse warpage is 0.004 inch. Check at points as indicated in figure 3-11A.

(2) *Leaks.* Install the injector hole tubes in the cylinder head. Install scrap or dummy injectors in the injector tubes to insure seating of the tubes. Hold the injector in place with the injector clamp and tighten the injector clamp nut to 20 to 25 ft-lb. torque. Install an oil gallery pipe in each end of the cylinder head leaving one oil gallery opening at each end. Seal all the water openings in the cylinder head with suitable gasket material and clamping fixture equipment. Apply 80 to 100 psi air pressure to the water jacket by drilling into one of the water hole clamping fixtures. Submerge the cylinder head in a tank of hot water heated to 180° F. and, with air pressure applied, watch for air bubbles in the water. Continue checking for air bubbles, which indicate leaks in the cylinder head, until the cylinder head has reached the temperature of the water. Inspect for leaks at the top and bottom of the injector tube, oil gallery, cylinder head stud holes, exhaust ports, and the top, bottom, and sides of the cylinder head proper. Relieve the air pressure and remove the cylinder head from the water. Remove the clamping fixtures and gasket material from the water openings and allow the cylinder head to dry. Replace any leaking injector hole tubes. Replace the cylinder head if any leaks are apparent.

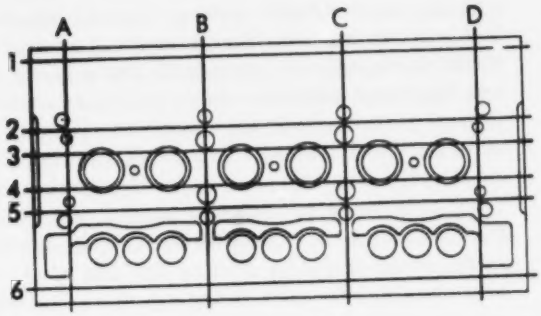
(3) *Valve guides.* Carefully inspect each valve guide for damage, out-of-round, scored, or worn condition. If the clearance between the valve guide and valve stem exceeds the limits listed in table 1-4, or if valve guide is damaged, replace the guide.

(4) *Valve seat inserts.* Inspect the valve seat inserts for cleanliness, concentricity, flatness, pitting, warping, presence of cracks, and wear beyond the limits listed in table 1-4. Replace a damaged or worn valve seat insert.

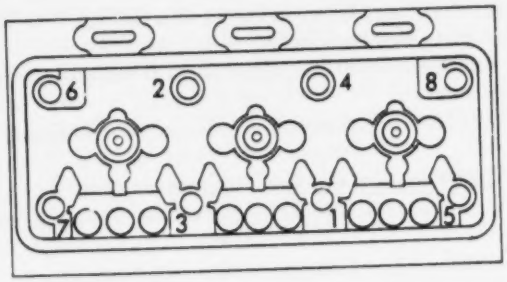
(5) *Engine lifter brackets.* Inspect all engine lifter brackets for cracks, breaks, or damaged threads. Replace a damaged lifter bracket.

(6) *Hardware.* Inspect all hardware for fatigue and damaged threads. Replace hardware as required.

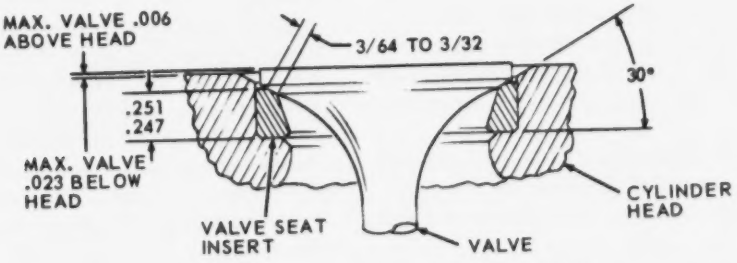
(7) *Water nozzles.* Inspect the water nozzles for cracks or bent nozzles. Replace a damaged nozzle.



A. HEAD FLATNESS CHECK POINTS.



B. CYLINDER HEAD TIGHTENING SEQUENCE



C. EXHAUST VALVE & INSERT POSITIONING

ME 3810-233-34/3-11

Figure 3-11. Cylinder head assembly, inspection, and installation data.

e. Valve Guide Replacement.

(1) Remove the exhaust valves (para 3-25).

(2) Drive the valve guides (3) out of the cylinder head, from the bottom, using a valve guide remover tool.

(3) Rest the bottom of the cylinder head assembly on the workbench.

(4) Locate the valve guide (3) squarely in the cylinder head with the countersunk end of the valve guide up.

(5) Position the valve guide installer on the valve guide and tap gently to start into place.

(6) With the valve guide properly started, drive it in until its upper end projects 1.530 inches above the top of the cylinder head.

f. Valve Seat Insert Replacement. The valve seat inserts are shrunk into the cylinder head and therefore must be removed with a valve seat insert removing tool.

(1) Support the cylinder head on its side and remove the valve seat inserts (23) with a suitable tool.

(2) Immerse the cylinder head in water of approximately 200° F. for 30 minutes. At the same time, cool the replacement valve seat insert as much as possible (use dry ice if available).

(3) Remove the cylinder head from the water and rest bottom side up on a workbench. Position the insert (23) squarely in the counterbore with the seating face up. Drive the insert in place with a suitable tool until it seats in the cylinder head.

CAUTION

Install the valve seat inserts in the cylinder head while head is still hot and the inserts are cold, otherwise the installation will be difficult and the parts may be damaged.

(4) Grind the valve seat inserts and check them for concentricity as outlined in *g.* below.

g. Valve Seat Insert Refacing. When new valve seat inserts are installed, or old inserts refaced, it is important that the angle of the valve seat insert be exactly the same as the valve seat faced so as to provide the proper seating of the valve. The correct angle for the seating face of both the valve and the valve seat insert is 30 ° (fig. 3-11). To recondition the valve seat insert angle, use a 30 ° grinding wheel on the valve seats and a 60 ° grinding wheel to open the throat of the insert to adjust the width of the valve seat. Be careful in grinding the valve seat and remove only a small amount of material. Remove the grinding tool and use a dial indicator to determine the concentricity of each valve seat in relation to its valve guide. Total runout should not exceed 0.002 of an inch. If this runout is exceeded, regrind the valve seat and recheck the runout. When the correct valve seat runout is obtained, check the position of the contact area between the

valve and valve seat. Apply a thin coat of prussian blue to the valve seat insert, place a valve with a clean, smooth face in the valve guide, and bounce it on the valve seat insert, but do not rotate the valve. The prussian blue will show, on the valve face, the points in the area of contact. The most desirable area of contact is at the center of the valve face. If the contact is too close to the top or bottom of the valve face, regrind the valve seat insert, recheck for concentricity, and retest for area of contact.

NOTE

After valve seat replacement and / or refacing, clean thoroughly with an approved solvent; dry and lubricate with clean, light oil.

h. Injector Hole Tube Replacement.

(1) With the cylinder head placed top up, turn an injector tube removing tap into the upper end of the injector hole tube (1, fig. 3-10) until approximately three-fourths of an inch of threads have been obtained.

(2) Place an injector tube removing rod through the small hole of the injector hole tube at the bottom of the cylinder head assembly and against the injector tube removing tap. Drive the injector tube from the cylinder head.

(3) With the cylinder head right side up, place the preformed packing (2) in the recess of the cylinder head injector bore.

(4) Position the injector hole tube (1) over the packing (2) and drive the tube into the cylinder head with a suitable driver. The injector hole tube is properly positioned when the flange at the upper end of the tube is seated on the packing and the tube is seated in the counterbore of the cylinder head.

(5) Flare the lower end of the injector hole tube with a suitable die to 30 ft-lb. torque.

(6) Ream the new injector hole tube, with a suitable tool, to fit the injector body nut and injector spray tip. Ream the excess stock from the lower end of the injector hole tube so that it is from flush to 0.010 of an inch below the finished surface of the cylinder head. Ream the level seat of the injector hole tube until the shoulder of the injector spray tip, when positioned in the tube, is from flush to 0.015 of an inch below the fire deck (bottom) of the cylinder head.

i. Assembly.

(1) Support the cylinder head on its side on the workbench and assemble the single outlet water nozzles (20, fig. 3-10) and the double outlet water nozzles (21) in the water openings in the cylinder head.

(2) Install the pipe plugs (17, 18, and 19) in the openings in the ends of the cylinder head and the pipe plugs (22) in the side of the cylinder head.

(3) Position the cover (11) with a new gasket (12) on the cylinder head assembly and secure with the two screws (9) and lockwashers (10). Install the cover on the opposite side of the cylinder head in the same fashion.

(4) Install the exhaust valves (para 3-25).

(5) Install the fuel injectors.

(6) Install the rocker arm assemblies (para 3-24).

(7) Install the injector control tube assembly.

(8) Install the fuel lines, adapters, and filters.

j. Installation.

(1) Be sure the top of the cylinder block and the pistons and liners are clean. Place new gaskets between the cylinder head and the cylinder block.

(2) Examine the four oil seal corner pins on the top surface of the cylinder block and replace if defective. Install a new oil ring in the groove.

(3) Attach the engine lifter brackets (14, fig. 3-10) to the cylinder head assembly without the gaskets to permit lifting the cylinder head into position.

NOTE

Lifter brackets must not be permanently attached until all the cylinder head stud nuts have been tightened to the correct torque.

(4) Insert the hooks of a hoist in the eyes of the front and rear engine lifter brackets and lower the cylinder head in place over the studs on the cylinder block. After positioning the cylinder head in place remove the front and rear lifter brackets. Install the cylinder head stud nuts and bolts (table 1-2). Start at the center and tighten the nuts and bolts in a uniform sequence as illustrated (fig. 3-11B).

(5) Position the engine lifter brackets (14, fig. 3-10) with new gaskets (13) on the cylinder head assembly and secure with the 4 lockwashers (15) and capscrews (16).

(6) Install the lockwashers and capscrews which secure the lifing brackets to the balance weight cover and flywheel housing. Tighten the capscrews to 50-60 ft-lb. torque.

(7) Connect the fuel lines to the fuel strainer and filter and install the filter units.

(8) Install the governor-to-cylinder head attaching bolts and lockwashers.

(9) Install the governor housing cap and fuel rod. Connect the throttle control linkage to the governor (para 3-43).

(10) Install the exhaust manifold (TM 5-3810-233-12).

(11) Install the water manifold (TM 5-3810-233-12).

(12) Install the air compressor (TM 5-3810-233-12).

(13) Refill the cooling system (TM 5-3810-233-12).

(14) Install the rocker arm cover (para 3-6).

NOTE

If the mounting bolts for the balance weight cover and flywheel housing were loosened to facilitate the removal of the cylinder head, tighten in accordance with the torque values specified in table 1-2.

3-24. Rocker Arm Assembly

a. General. Three rocker arms are provided for each of the three cylinders. The two outer arms operate the exhaust valves and the center arm operates the fuel injector. Each rocker arm assembly pivots on a shaft supported on the cylinder head by two brackets. The rocker arms are operated by the camshaft through short push rods extending through the cylinder head. Contact between each cam follower and the camshaft is effected by a hardened roller which is held in place on the bottom of the cylinder head by a cam roller guide.

b. Removal.

(1) Remove the fuel lines (para 3-15).

(2) Remove the bolts (8, fig. 3-12) that secure the rocker arm shaft brackets (9) to the cylinder head. Remove the brackets.

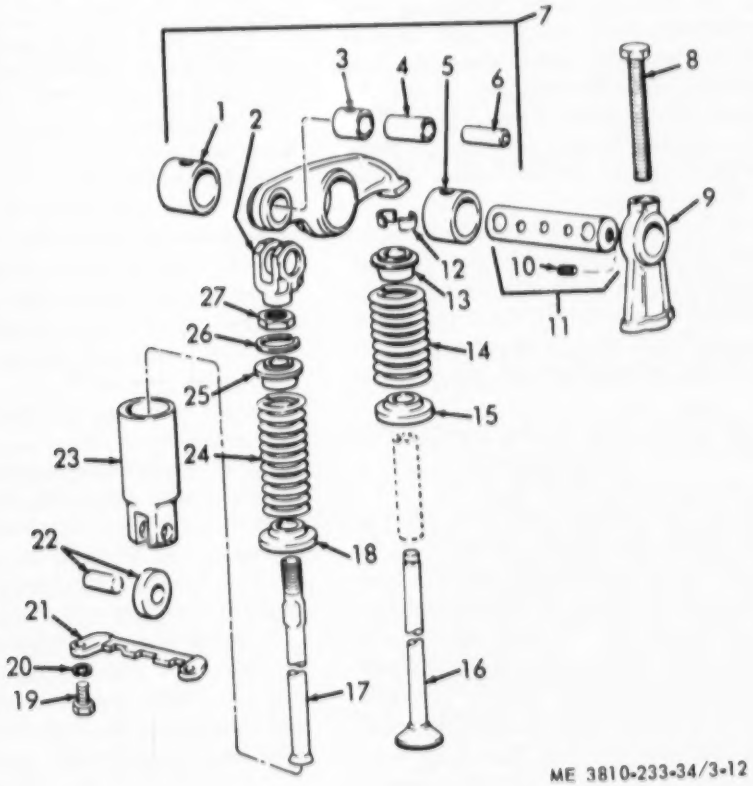
(3) Slide the rocker arm shaft (11) out of the rocker arm assembly (7).

(4) Place the cylinder head on its side and remove the capscrews (19) and lockwashers (20) that secure the cam roller guide (21) to the cylinder head. Remove the guide and cam push rod follower assemblies (23) from the head.

(5) Loosen the nuts (27) and unscrew each of the push rods (17) from the clevises (2). Remove the push rod and spring assemblies from the cylinder head.

(6) Repeat the operation on the remaining rocker arm assemblies.

(7) Remove the spring seat retainer rings (26) from the cylinder head.



1 Bushing
2 Clevis
3 Bushing
4 Bushing
5 Bushing
6 Pin
7 Rocker arm assembly
8 Bolt
9 Bracket
10 Plug
11 Shaft
12 Lock
13 Spring cap
14 Valve spring
15 Spring seat
16 Exhaust valve
17 Push rod
18 Seat
19 Screw
20 Lockwasher
21 Follower guide
22 Roller set
23 Follower assembly
24 Spring
25 Seat
26 Retainer ring
27 Nut

Figure 3-12. Rocker arm, push rod, shaft, and valves, exploded view.

c. Disassembly.

(1) Remove the nut (27) and push rod spring seat (25) from the push rod (17) and depress the spring. Separate the compression spring (24), push rod spring seat (18), and push rod (17).

(2) Drive the straight headless pin (22) from the cam push rod follower assembly (23) and separate the cam follower roller (22) from the follower.

(3) Press the straight headless pins (6) from the rod end clevises (2) and remove the clevises from the rocker arms.

(4) Remove the sleeve bushing (3 and 4) from the rocker arms.

(5) Remove the sleeve bushings (5) from the exhaust valve rocker arms.

(6) Remove the sleeve bushings (1) from the fuel injector rocker arm.

(7) Disassemble the two remaining rocker arm assemblies in the same manner as described above.

d. Cleaning, Inspection, and Repair.

(1) Wash all parts thoroughly with an approved cleaning solvent and dry thoroughly.

(2) Clean all lubricating oil passages with compressed air or, if necessary, use a wire probe.

(3) Examine the bushings and pins of the rocker arms and if scored, pitted, or scratched, replace them.

(4) Examine the rocker arm exhaust valve and injector contact surfaces where they contact the valve poppet and plunger lifter and if damaged or worn, grind to the original contour or replace them.

(5) Inspect the valve push rods for wear or scoring. If the push rods have "shoulders" or "ridges" due to the rocker arm action on the push rods, replace the push rods. Replace a bent push rod.

(6) Examine the cam follower rollers and pins for scored, pitted, scratched, cracked, or out-of-round surfaces. Replace a damaged roller or pin.

(7) Examine the compression springs for cracks, breaks, pitting, bent condition, or weakness. Replace a damaged spring.

(8) Examine all hardware for cracks, breaks, and stripped or crossed threads. Replace all damaged hardware.

(9) Refer to table 1-4 for the fits and tolerances for the rocker arm assembly, and replace parts as required.

e. Assembly.

(1) Press the bushings (1) in the fuel injector rocker arm assemblies.

(2) Press the bushings (5) in the exhaust valve rocker arm assemblies.

(3) Press the bushings (3) in the rocker arms. Install the small bushings (4) in the bushings (3). Position the clevises (2) on the rocker arm assemblies and install the straight headless pins (6).

(4) Assemble the push rod spring seat (18), compression spring (24), and push rod spring seat (25) on the push rod (17). Compress the spring and secure to the push rod with the nut (27).

(5) Aline the cam follower rollers (22) in the cam push rod follower assemblies (23) and secure with the straight headless pins (22).

(6) Reassemble the remaining rocker arm assemblies in the same manner as described above.

f. Installation.

(1) Install the spring seat retaining ring (26) in the push rod openings in the cylinder head.

(2) Slide the push rod and spring assemblies into position from the bottom of the cylinder head.

NOTE

The injector rocker arm assemblies are slightly different from the exhaust valve rocker arms. The boss for the shaft on the exhaust valve rocker arms is longer on one side of the arm than on the other. The extended boss on each of the valve rocker arms must face the injector rocker arms.

(3) Turn the nut (27) on to the upper end of the push rod as far as possible and screw the push rod into the rod end clevis (2) until the end of the push rod contacts the rocker arm.

NOTE

There is an oilhole in the bottom of the cam follower. Install the cam follower with the oilhole pointing away from the valves, so that the hole is not covered by the follower guide.

(4) With the cam follower rollers (22) pointing across the cylinder head, slide the cam push rod follower assemblies (23) into position over the push rod and spring assemblies.

(5) Position the cam roller guides (21) on the bottom of the cylinder head and secure with the capscrews (19) and lockwashers (20).

(6) Lubricate the outer surface of the rocker arm shafts (11) and install in the shaft openings in the rocker arms (7).

(7) Install a shaft bracket (9) on each end of the rocker arm shaft. Aline the brackets with the mounting holes in top of the cylinder head and fasten with the bolts (8). Torque the bolts in accordance with data in table 1-2.

(8) Replace the fuel lines (para 3-15).

3-25. Exhaust Valves

a. Removal.

(1) Remove the cylinder head (para 3-23).

(2) Remove the injector control tube assembly (para 3-8).

(3) Remove the fuel injectors (para 3-15).

(4) Remove the rocker arm assemblies (para 3-24).

(5) Support the bottom of the cylinder head on a workbench with a two-inch block placed between the valve heads and the workbench.

(6) Thread a valve spring compressor adapter

into the rocker arm shaft bolt hole in the cylinder head. Press the handle of the compressor adapter to compress the valve spring (14, fig. 3-12) and remove the two valve seat spring retainers (12).

(7) Release the spring compressor adapter and remove the spring cap (13), valve spring (14), and spring seat (15).

(8) Remove the cam follower assemblies and push rod assemblies (para 3-24).

(9) Remove the exhaust valves (16).

NOTE

Number each valve to facilitate reassembly.

b. Cleaning, Inspection, and Repair.

(1) Carefully scrape and wire brush all grime and carbon deposits from the valve stems.

(2) Clean the valves with an approved cleaning solvent and wipe dry.

(3) Inspect the valve for cracked, pitted, cupped, and excessively thin faces. Examine the valve stem for scoring, warpage, or excessive wear. Carbon on the face of the valve indicates a faulty seat and a resultant leak or "blow-by". Replace a damaged valve or reface the valve to an angle of 30° as instructed in *c* below.

CAUTION

The valve face angle must be identical to the valve seat insert angle. See paragraph 3-23.

(4) Replace any valves worn beyond the tolerances given in table 1-4.

(5) If a new valve is installed, the valve head must not protrude more than 0.0060 of an inch above the surface of the cylinder head. The valve seat diameter on a used valve will decrease after several reconditionings, so that the valve will rest in a lower position on the valve seat insert. It must not exceed 0.0230 of an inch below the cylinder head surface. Replace the valve if these limits are exceeded.

(6) Examine the valve springs for pitted or broken coils, inadequate tension, and elongation. Free length should be 2⅜ inches. Test the valve spring tension in an approved valve spring tester. Compress each valve spring to 2 3/16 inches in length. The pressure reading should be 44 pounds. The spring compressed to 1 54/64 inches should give a reading of 135.5 to 144.5 pounds. Replace all weak or defective valve springs.

c. Valve refacing.

(1) Install the valve in a valve refacer tool, making sure the grinding wheel is properly trued, and set the chuck at 30° angle. Then take a light cut from the face of the valve, removing a small amount of material from the valve face.

(2) Remove the valve from the facing tool and make the prussian blue test as described for the valve seat insert in paragraph 3-23. Regrind the valves if necessary.

d. Assembly and Installation.

(1) Apply a light coat of engine oil to the stem of the valve (16, fig. 3-12) and slide the valve into the installed valve guides.

(2) Hold the valve in place with a strip of masking tape and turn the bottom of the cylinder head down on the workbench.

NOTE

Support the cylinder head by placing a 2 inch block between the head and work bench. This will support the valves and keep the cam followers clear of the bench.

(3) Install the valve spring seat (15) and valve spring (14) on the valve stem. Install the valve spring cap (13) in the valve spring.

(4) Compress the valve spring with valve spring compressor. Install the two-piece tapered valve lock (12).

(5) Release and remove the valve spring compression.

(6) Install all valves according to the procedure described in (1) through (5) above.

(7) Install the fuel injectors (para 3-20).

(8) Install the head assembly (para 3-23*j*).

(9) Install the rocker arm assemblies (para 3-24*f*).

(10) Install the injector control tube assembly (para 3-12).

(11) Install the governor assembly (para 3-46*b*).

(12) Install the fuel lines (para 3-20*g*).

e. Valve Adjustment. An initial and a final exhaust valve adjustment will be required if the engine is cold. If the engine is at normal operating temperature, the initial adjustments may be eliminated.

(1) *Initial adjustment (cold engine).*

(a) Remove the rocker cover.

(b) Place the governor throttle control lever in the NO FUEL position.

(c) Rotate the crankshaft until the injector follower is fully depressed on the cylinder to be adjusted.

(d) Loosen the push rod locknut.

(e) Insert a 0.013 inch feeler gage between valve stem and rocker arm (fig. 3-13).

(f) Adjust the push rod until a smooth "pull" is obtained with the feeler gage.

(g) Hold the push rod securely in place with one wrench and tighten the lock nut securely.

(h) Recheck the clearance. If adjustment is correct, the 0.011 inch feeler gage will pass freely between valve stem and rocker arm but the 0.013 gage will not.

(i) Repeat adjustment procedure on remaining valves.

(2) *Final adjustment (hot engine).*

(a) Run the engine until normal operating temperature (175—185 degrees F.) is reached.

(b) Repeat adjustment procedure as outlined in *a* above but use 0.010 inch and 0.008 inch feeler gages instead of the 0.013 and 0.011 inch gages used in the ititial adjustment.

(c) Repeat the final adjustment procedure on the remaining valves.

Figure 3-13. Adjusting the exhaust valves.

Section VI. CRANKCASE OIL PAN, LUBRICATING OIL PUMP, OIL PRESSURE REGULATOR AND OIL COOLER

3-26. General

The lubricating system consists of a cast iron oil pan, oil pump, oil pressure regulating valve, and oil cooler. The oil is circulated by the gear-type pressure pump mounted on the crankshaft main bearing caps and gear driven from the crankshaft. All of the oil from the oil pan is forced through the full-flow oil filter and into the lubricating system (fig. 1-11). Continuous flow of oil is assured by the regulating valve and by-pass valves. The oil cooler performs a dual function in that it cools the hydraulic transmission fluid in addition to the engine lubricating oil. All of the components in the lubricating system may be removed without removing the engine from the crane chassis.

3-27. Oil Pan

a. Removal.

(1) Remove the pipe plug (8, fig. 3-14) and drain the oil pan (9).

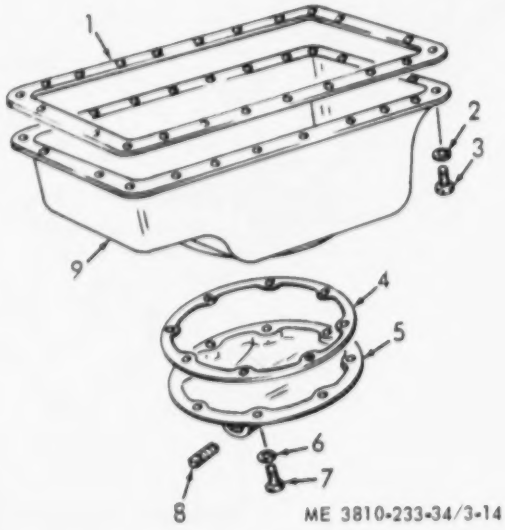
(2) Remove the 22 capscrews (3) and lockwashers (2).

(3) Remove the oil pan and gasket (1) from the engine block.

b. Disassembly.

(1) Remove the eight capscrews (7) and lockwashers (6).

(2) Remove the cover (5) and gasket (4).



1 Gasket
2 Lockwasher
3 Capscrew
4 Gasket
5 Cover
6 Lockwasher
7 Capscrew
8 Plug
9 Oil pan

Figure 3-14. Oil pan, exploded view.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Remove all traces of gasket material from the machined surfaces of the oil pan and cover.

(2) Inspect the oil pan and cover for cracks or other damage. Repair or replace as required.

d. Installation.

(1) Install a new gasket (4) and cover (5) on the oil pan (9).

(2) Install a new gasket (1) and oil pan (9) on the block. Tighten the capscrews to 10-12 ft-lb. torque.

(3) Replace the oil pan drain plug (8); tighten to 35-40 ft-lb. torque. Service the crankcase (TM 5-3810-233-12).

3-28. Oil Pump

a. General.

(1) The gear-type oil pump (fig. 3-15) is mounted on the first and second main bearing caps. The pump is gear driven from the front end of the crankshaft.

(2) The oil pump intake screen (42, fig. 3-16) should be inspected and cleaned every time the oil pan is removed.

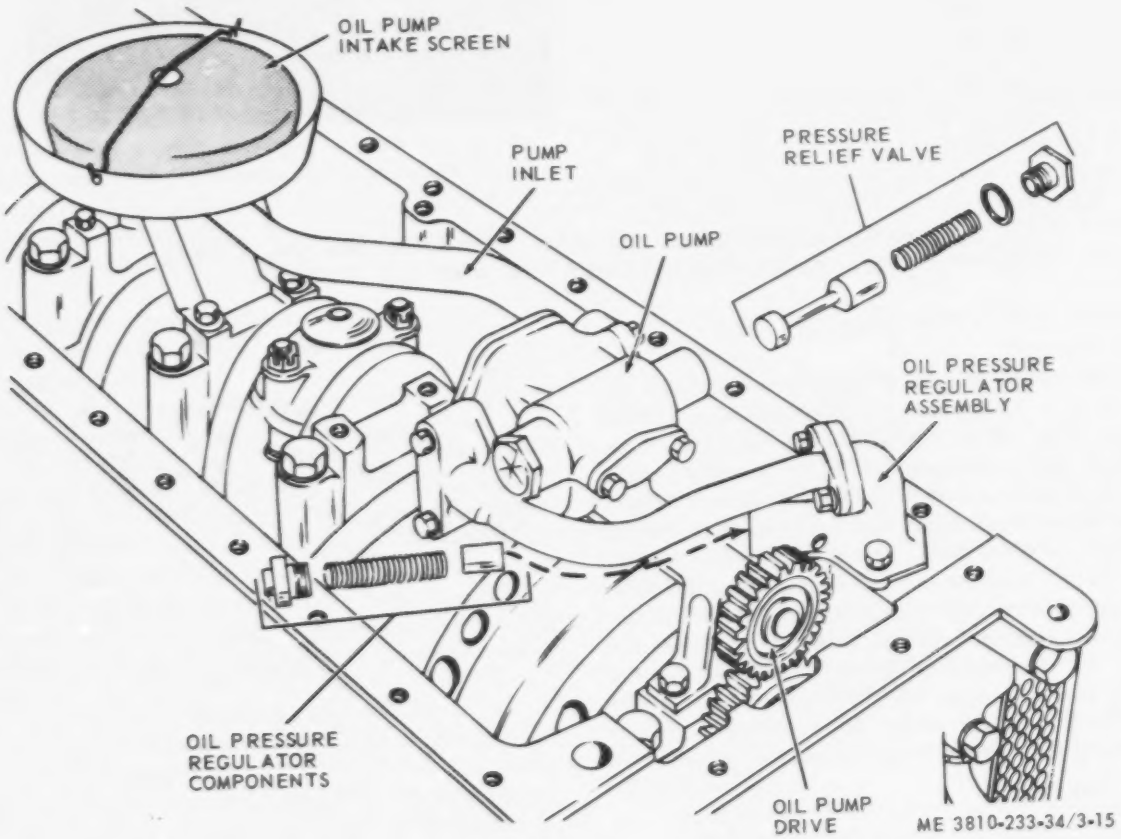
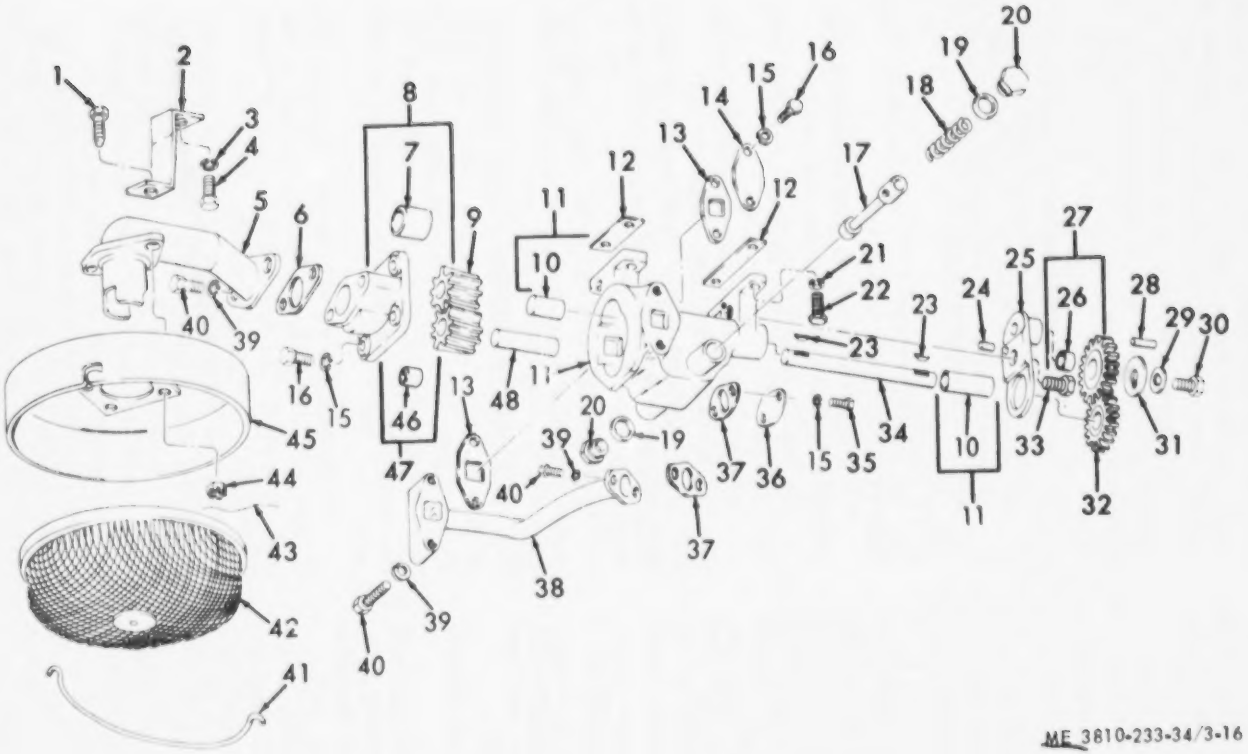


Figure 3-15. Oil pump mounting details with oil pan removed.



ME 3810-233-34/3-16

1 Screw
2 Bracket
3 Lockwasher
4 Capscrew
5 Inlet pipe
6 Gasket
7 Bushing
8 Cover
9 Gear
10 Bushing
11 Body
12 Shim
13 Gasket
14 Cover
15 Lockwasher
16 Capscrew
17 Valve
18 Spring
19 Gasket
20 Plug
21 Washer
22 Screw
23 Key
24 Pin
25 Support
26 Bushing
27 Gear
28 Pin
29 Lockwasher
30 Capscrew
31 Washer
32 Gear
33 Capscrew
34 Shaft
35 Capscrew
36 Cover
37 Gasket
38 Outlet pipe
39 Lockwasher
40 Capscrew
41 Retainer
42 Screen
43 Wire
44 Nut
45 Screen cover
46 Bushing
47 Gear
48 Shaft

Figure 3-16. Oil pump assembly, exploded view.

b. Removal.

(1) Remove the oil pan (para 3-27).

(2) Remove the two capscrews (4, fig. 3-16) and lockwashers (3) which attach the screen bracket to the bearing cap.

(3) Remove the two capscrews (3, fig. 3-18) and lockwashers (2) which attach the oil pressure regulator body (1) to the cylinder block.

(4) Remove the four capscrews (22, fig. 3-16) and lockwashers (21) which attach the pump assembly to the bearing caps.

(5) Remove the complete assembly.

NOTE

Remove and save the shims (12), if used between the pump mounting feet and bearing caps.

c. Disassembly.

(1) Remove the two capscrews (40) and lockwashers (39) which attach the outlet pipe (38) and oil regulator assembly to the pump body (11). Remove the complete assembly.

(2) Remove the two capscrews (40) and lockwashers (39) which attach the inlet pipe (5) to the pump body (11). Remove the inlet pipe and screen.

(3) Remove the four capscrews (16) and lockwashers (15) which secure the cover (8) to the pump body (11). Remove the cover (8).

(4) Remove the two valve plugs (20) and copper gaskets (19) from the pump body (11). Jar the relief valve (17) and spring (18) from the pump body.

(5) Remove the pump driven gear (47) from the driven gear shaft (48).

(6) Straighten the lip of the lockwasher (29) and remove the bolt (30), lockwasher, and flatwasher (31). Remove the idler gear (27).

(7) Clamp the pump body in a vise and remove drive gear (32) with a gear puller.

(8) Remove the key (23) and remove the shaft (34) and driven gear (9) from the pump body (11).

(9) Remove the capscrew (33) and the idler gear support (25) from the pump body (11).

(10) Place the gear and shaft assembly in an arbor press and press the drive shaft (34) from the gear (9). Remove the key (23) from the drive shaft.

(11) Remove the retainer (41) and screen (42).

(12) Remove the two capscrews (1) and nuts (44). Remove the inlet pipe (5) from the screen cover (45).

d. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry all parts thoroughly with compressed air.

(2) Inspect the gear cavity in the pump body and drive shaft bushing (10). If the pump body is scored, replace with new body and cover. Replace bushings if scored or worn.

(3) Inspect teeth of drive and driven gears (9). If scored or worn, install new gears.

NOTE

A kit containing shafts, gears, bushings, valve spring, and gaskets required to overhaul the oil pump is available. Refer to appropriate functional group in repair parts list.

(4) Inspect the driven gear bushing (46). If worn, replace. Ream replacement bushings to 0.0005 inch clearance after installing in gear.

(5) Inspect the valve (17), spring (18), and pressure relief valve seat in pump body (11). If necessary, install new parts.

NOTE

The valve spring has a free length of approximately 2-5/16 inches and requires a pressure of 45-55 pounds to compress it to a length of 1⅝ inches. If the compression pressure or free length is 10 percent less than the above figures, replace the spring.

e. Assembly.

(1) Place the key (23) in the shaft (34). Lubricate shaft with engine oil.

(2) Place drive gear (9) with keyway on shaft and press into correct position (fig. 3-17).

(3) Replace pin (24, fig. 3-16) in pump body (11) if removed.

(4) Position the idler gear support (25) on the pump body and secure with capscrew (33).

(5) Install the drive gear and shaft assembly in the pump body. Install the driven gear (47) on the shaft (48).

(6) Install the cover (8) on the pump body and secure with four capscrews (16) and lockwashers (15).

(7) Support the gear end of the drive shaft (34) in an arbor press; insert the key (23) in the shaft. Position gear (32) on shaft with gear hub away from pump body and press on shaft until the clearance between the gear and pump body is 0.005 inch.

(8) Replace the pin (28) in the idler gear (27) if removed. Lubricate the bearing surface on the support bracket (25) and install the gear (27) with the flat side facing the bracket.

(9) Place the lockwasher (29) on the capscrew (30), then the special washer (31). Engage the capscrew in the support bracket. Rotate the special washer and lockwasher so that the slot in each washer engages the pin (28) in the gear (27).

(10) Tighten the capscrews (30) until one hex of the head is over the end of the pin. Bend the lockwasher against one flat of the capscrew head.

(11) Screw plug (20) with gasket (19) into pump body opposite the inlet opening. Insert the valve (17) and spring (18) into the pump body on the inlet side and secure with second gasket (19) and plug (20).

(12) Assemble remaining parts in reverse order of removal.

NOTE

Replace all used gaskets with new ones.

(13) The pump must turn freely after assembly. Any binding action must be corrected before installation on the engine.

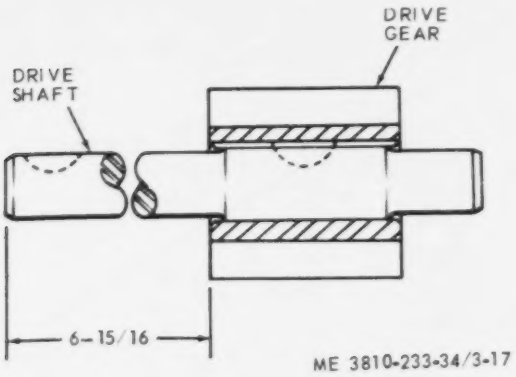


Figure 3-17. Drive gear position on shaft.

f. Installation.

(1) Install the oil pump assembly on the bearing caps with the four capscrews (22) and lockwashers (21). Aline the pump so that the teeth of the idler gear and crankshaft are parallel.

(2) Tighten the mounting screws to a torque of 35-40 ft-lb.

(3) Check the clearance between the gear teeth with a feeler gage. Minimum clearance is 0.002 inch and maximum clearance is (0.006 inch with new gear and 0.012 inch for worn gear). Adjust clearance by removing or adding shims under pump body mounting feet.

CAUTION

The same number of shims must be placed under each mounting foot. If a new idler gear was installed, additional shims must be added. Each 0.005 inch shim added increases the clearance of the teeth by 0.0035 inch.

(4) Complete assembly and installation in the reverse order of disassembly and removal.

(5) Install the oil pan (para 3-27).

(6) Service the crankcase in accordance with the current lubrication order.

3-29. Oil Pressure Regulator

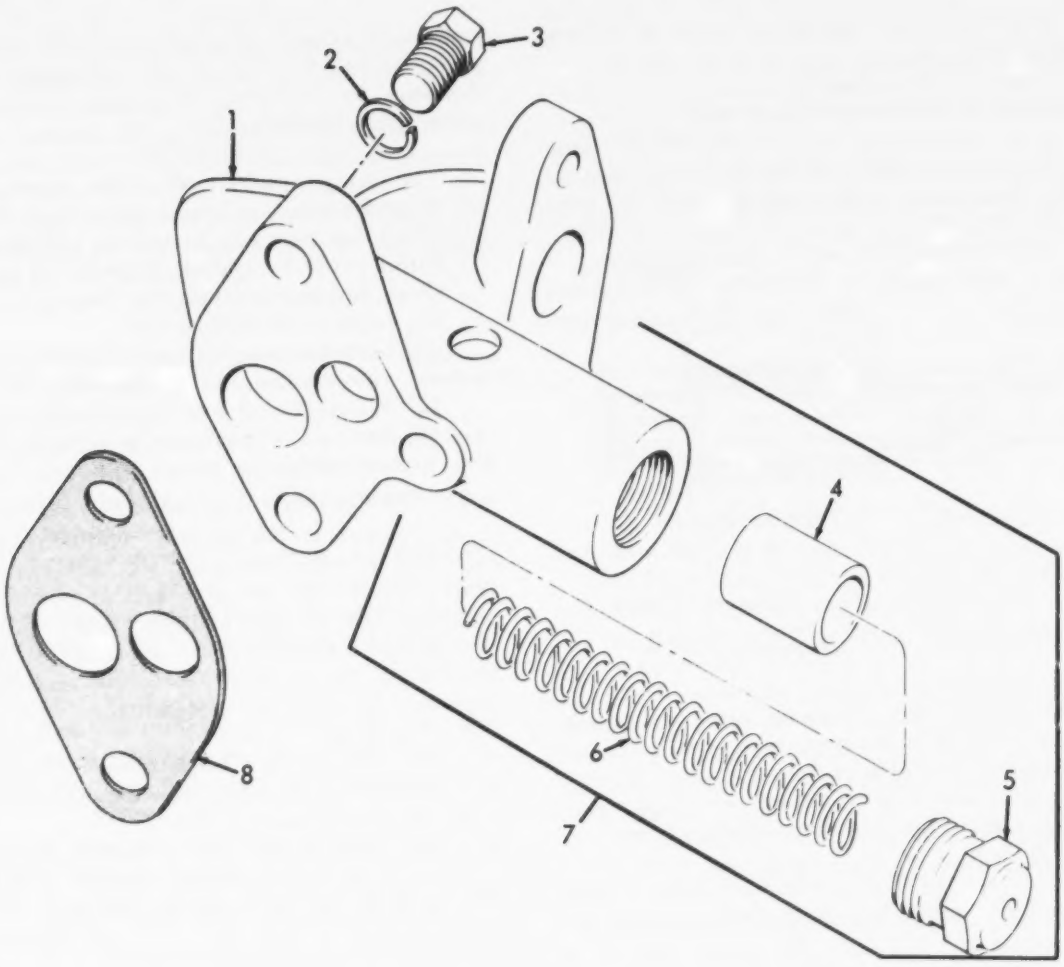
a. General. Under normal conditions, the oil regulator pressure assembly will not require attention other than cleaning and inspection while servicing the oil pump (para 3-28). However, occasionally sludge may accumulate in the lubricating system and necessitate servicing the regulator assembly independently.

b. Removal.

(1) Remove the oil pan (para 3-27).

(2) Remove the outlet pipe capscrews (40, fig. 3-16) and lockwashers (39).

(3) Remove the two body-to-cylinder capscrews (3, fig. 3-18) and lockwashers (2). Remove the regulator assembly and gasket (8).



ME 3810-233-34/3-18

1 Body
2 Lockwasher
3 Screw
4 Valve
5 Plug
6 Spring
7 Regulator assembly
8 Gasket

Figure 3-18. Oil pressure regulator assembly, exploded view.

c. Disassembly.

(1) Remove the plug (5) from the body (1, fig. 3-18).

(2) Remove the spring (6) and valve (4) from the body.

d. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly. Make sure all passages in the body are clean.

(2) Make sure that the regulator valve moves freely in the body.

(3) Check the free length of the spring. It should measure 2 7/16 inches minimum and compress to not less than 1⅝ inches with maximum pressure between thumb and forefinger applied to the spring ends. Replace as required.

e. Assembly.

(1) Apply clean engine oil to the outer surface of the valve and slide the valve into the body, closed end first.

(2) Insert the spring; compress, and start the plug.

(3) Tighten the plug.

f. Installation.

(1) Install oil pressure regulator assembly with new gasket (8) on cylinder block.

(2) Complete reinstallation in accordance with reverse instructions in subparagraph *b* above.

3-30. Oil Cooler

a. Removal.

(1) Drain engine coolant system by opening drain cocks on radiator, oil cooler and water pump.

(2) Loosen hose clamp on hose to water pump.

(3) Disconnect hose to cab heater.

(4) Disconnect two tube assemblies to transmission housing.

(5) Disconnect two hose assemblies to engine oil filter.

(6) Disconnect hose to bottom of radiator.

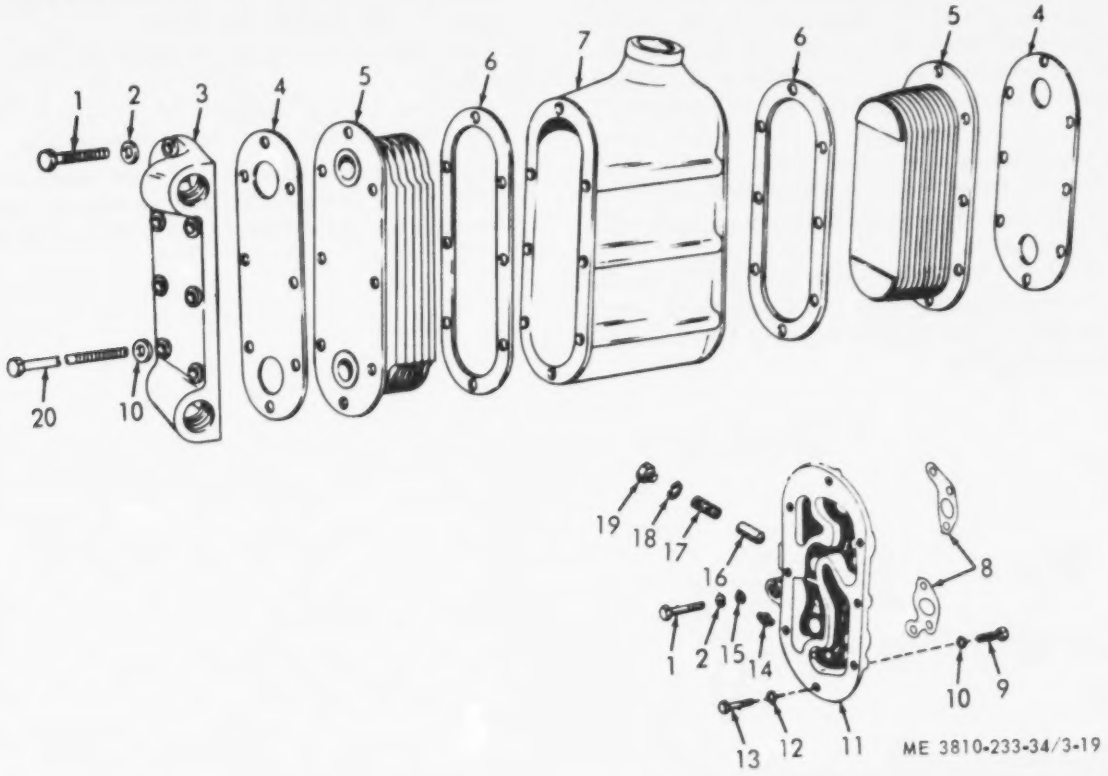
(7) Remove six long bolts (20, fig. 3-19) and remove oil cooler.

(8) Remove the bolts (1 and 13, fig. 3-19), lockwashers (2 and 12), and adapter (11) from the cylinder block. Remove and discard the old gaskets (8).

CAUTION

Do not lose copper washer (15) on lower left hand adapter capscrew.

(9) Remove plug (19), gasket (18), spring (17), and valve (16) from adapter.



1 Bolt
2 Lockwasher
3 Cover
4 Gasket
5 Core assy.
6 Gasket
7 Housing
8 Gasket
9 Bolt
10 Lockwasher
11 Adapter
12 Gasket
13 Bolt
14 Pipe plug
15 Washer
16 Valve
17 Spring
18 Gasket
19 Plug
20 Bolt

Figure 3-19. Oil cooler assembly, exploded view.

b. Cleaning, Inspection and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly.

(2) Clean the oil passages in the cooler cores (5) by circulating a trichloroethylene solution through the passages with a force pump.

CAUTION

Perform this operation in a well-ventilated area. Avoid breathing the fumes or direct contact of the chemicals with the skin.

(3) Remove the chemical solution by circulating an alkaline solution through the oil passages and flushing thoroughly with clean, hot water.

NOTE

Do not attempt to clean the cores when an engine failure has occurred and there is a possibility that metal particles have entered the lubricating system. Replace the cores instead.

(4) Clean the water side of the cooler cores by immersing in a 2½-gallon solution comprised of two-thirds water and one-third muriatic acid with

½ pound of oxalic acid added. The cleaning action will be completed in one minute as evidenced by the cessation of bubbling in the cleaning solution.

CAUTION

Avoid breathing the fumes or contact of the solution with the skin.

(5) Thoroughly flush the cores with clean, hot water and dip the cores in light oil.

(6) Test the cores for leaks by making a suitable plate and rubber gasket and attaching to the flanged side of the cooler core, (fig. 3-20). Connect a suitable source of air (75 psi) and immerse the core in water. The presence of bubbles indicates a leaky core which must be replaced.

NOTE

When a leaking core is found, flush the engine lubricating system to remove all contaminated oil.

(7) Remove the cores and dry thoroughly with compressed air.

(8) Test the bypass valve spring (17, fig. 3-19), by compressing under 10-12 pounds of force. If the spring compresses to a length of 1.800 inches, replace the spring.

c. *Installation.*

(1) Install the bypass valve assembly in the adapter (11). Make sure that the valve (16) slides freely in the adapter.

(2) Affix new gaskets (8) on the bosses on the cylinder block and install the adapter (11) on the block with capscrews (1 and 13) and lockwashers (2 and 12).

NOTE

Do not forget to replace the copper washer on the capscrew from which it was removed.

(3) Install the oil cooler on the engine with six long bolts.

NOTE

Use a torque of 13-17 ft-lb to tighten mounting bolts.

(4) Reconnect all hose and tube assemblies.

(5) Close drain cocks and service radiator, crankcase and transmission (TM 5-3810-233-12).

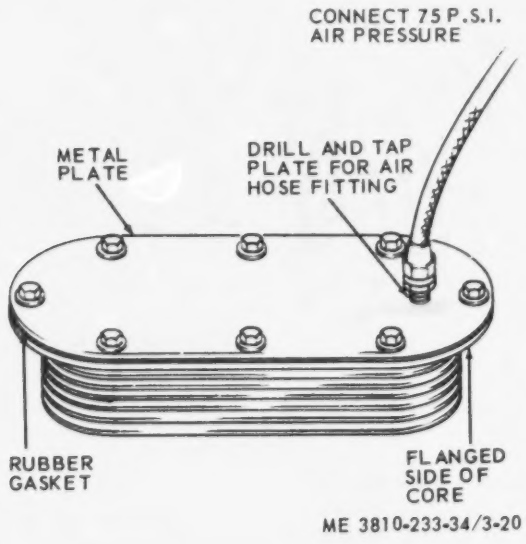


Figure 3-20. Cooler core prepared for leak test.

Section VII. PISTONS AND CONNECTING RODS

3-31. General

Malleable iron pistons are connected by piston pins to the upper end of drop-forged, carbon-steel connecting rods. The lower end of the connecting rods are attached to the crankshaft by bearing caps. The extra long piston skirts, accurately ground to full length, are plate with a protective coating of tin, which permits close fitting. Each piston is fitted with six piston rings. Four compression rings are placed above the piston pin and two three-piece, oil control rings are placed below the pin to wipe any excessive lubricating oil being thrown onto the cylinder liners by the crankshaft and the lower end of the connecting rod.

NOTE

Cylinder liners, although as a functional group item are considered as a component of the cylinder block, are normally supplied with the piston assembly as a matched component.

3-32. Removal

a. Remove the cylinder head (para 3-23).

b. Remove the crankcase oil pan (para 3-27).

c. Remove the lubricating oil pump (para 3-28).

d. Remove the carbon from the upper, inner surface of the cylinder sleeve. Remove any ridge in the cylinder sleeve at the top of the ring travel.

e. Remove the cotter pins (2, fig. 3-21) and nuts (1) from the connecting rod bolts (5). Slide the connecting rod bearing cap off the lower end of the connecting rod.

f. Push the piston and connecting rod assembly through the top of the cylinder block. Repeat the procedure for all pistons and connecting rod assemblies.

NOTE

The pistons cannot be removed from the bottom of the cylinder block.

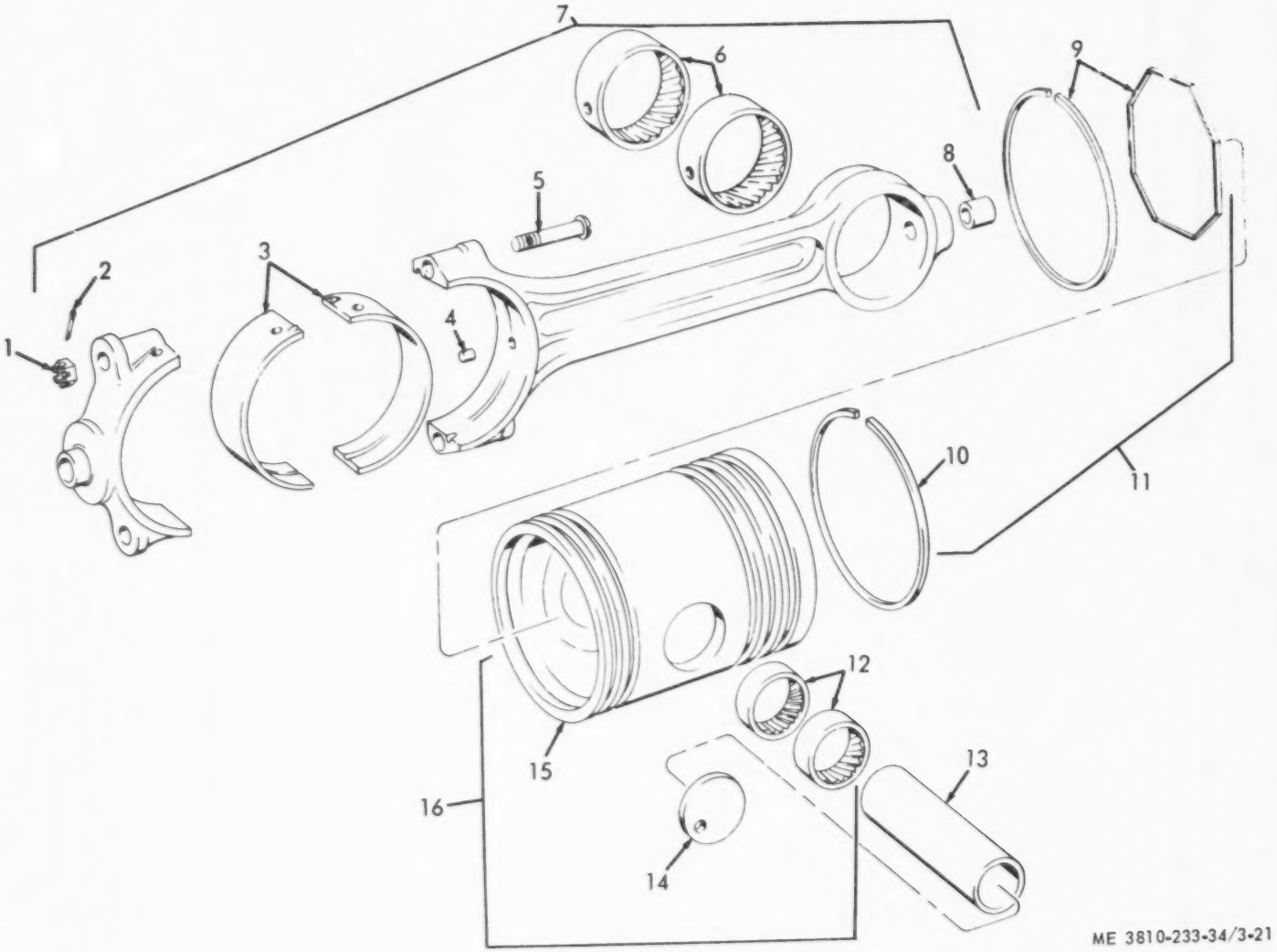


Figure 3-21. Connecting rod, piston and ring assembly, exploded view.

Key to figure 3-21:

1 Nut
2 Cotter pin
3 Bearing half set
4 Orifice
5 Bolt
6 Bushing
7 Rod assembly
8 Nozzle
9 Oil ring (w / expander)
10 Compression ring
11 Ring set
12 Sleeve bearing
13 Piston pin
14 Retainer
15 Piston
16 Piston assembly

3-33. Disassembly

a. Remove the connecting rod sleeve bearings (3, fig. 3-21) from the lower end of the connecting rod and bearing cap.

b. Punch a hole through one of the piston pin retainers (14) and pry the retainer from the piston (15), being careful not to damage the piston.

c. Remove the piston pin (13) and drive the other retainer from the inside of the piston.

d. With a suitable expander tool, remove the oil rings (9), and the compression rings (10).

e. Remove the sleeve bearings (12) from the piston (15).

f. Remove the sleeve bearings (6), orifice (4), and spray nozzle (8) from the connecting rod.

g. Disassemble the remaining pistons and connecting rods in the same manner.

3-34. Cleaning, Inspection, and Repair

a. Pistons.

(1) Clean the pistons with an approved cleaning solvent and dry with compressed air. Be sure the pistons are absolutely clean.

(2) Inspect the pistons and rings for cracks, scoring, and breaks. Inspect the inside of the piston, struts, and ribs for cracks. Replace all defective parts.

b. Fitting Pistons.

(1) Measure pistons and bore for pistons in the cylinder sleeves with the temperature at 70° F.; take the piston skirt measurement lengthwise and that of the piston pin crosswise.

(2) The piston should be round within 0.0005 inch. New cylinder liner bores should be round within 0.0001 inch. Measure the clearance of the piston in the cylinder liner bore by placing a ½-inch feeler ribbon, about 15 inches long, between the piston and the liner. Move the feeler ribbon 90° and recheck the clearance. Refer to table 1-4 for standard clearances and allowable wear limits between the cylinder liner and the piston skirt.

(3) If the piston binds in the cylinder liner, remove both piston and liner and check dimensions in accordance with table 1-4. Reinstall or replace cylinder liner as required, figure 3-22.

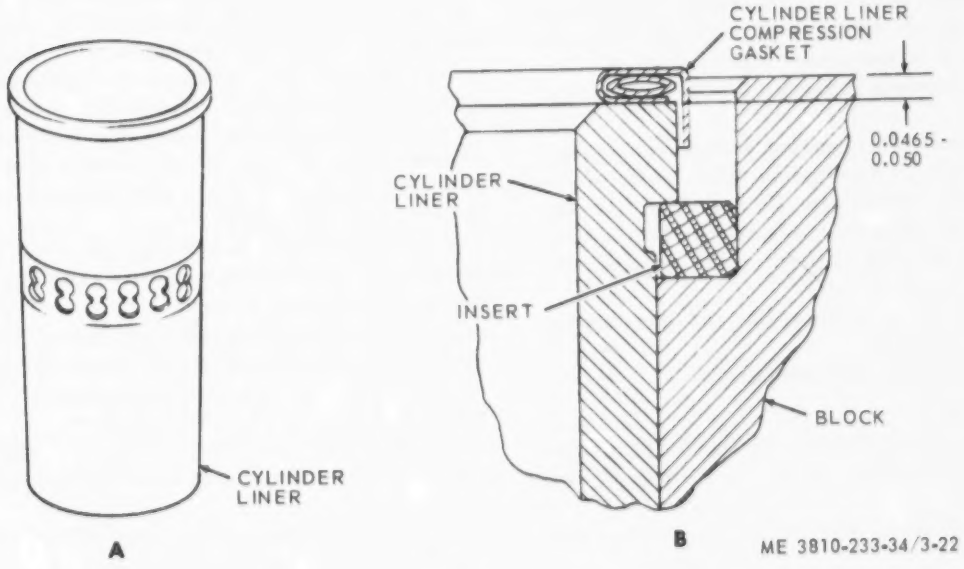


Figure 3-22. Cylinder liner installation.

c. Piston Pin Bushings.

(1) Clean the piston pin sleeve bushings with an approved cleaning solvent and dry with compressed air. Inspect the bushings for cracks and scoring.

(2) Measure the inside diameter of the bushings in accordance with table 1-4.

(3) Replace defective bushings.

d. Piston Pins.

(1) Clean the piston pins with an approved

cleaning solvent and thoroughly dry. Inspect the pins for cracks and scoring.

(2) Measure the outside diameter of the piston pin in accordance with table 1-4. Replace a defective piston pin.

e. Piston Rings.

(1) Inspect the rings for a free fit in the piston grooves, for side clearance, and for wear in accordance with table 1-4.

(2) New piston rings must be used when new pistons are installed. If the engine has been in service for a long time, replace the rings even though the same pistons are used.

f. Fitting Piston Rings.

(1) Insert one piston ring at a time, inside the cylinder sleeve, far enough down in the bore to be on the ring wiping area. Measure the ring gap in accordance with table 1-4.

(2) If the piston ring gap is below the limits given in table 1-4, increase the gap by filing the ends of the ring.

g. Connecting Rods.

(1) Clean the connecting rods with an approved cleaning solvent and dry with compressed air.

(2) Be sure all oil passages are clean and free of obstructions.

(3) Inspect the spray orifice and orifice plug for cracks and damage.

(4) Inspect the connecting rod bolts and nuts for cracks and damaged threads.

(5) Measure the outside diameter of the piston pin and the inside diameter of the bushing in the connecting rod to determine the amount of wear. Replace the bushings if beyond the limits described in table 1-4.

(6) Inspect the bearing halves for cracks, dents, chipping, and corrosion. The backs of the bearing halves should also be inspected for any bright spots. Bright spots indicate the halves have been moving in their supports and are unfit for further use.

(7) Inspect the connecting rod for cracks, breads, and warpage.

(8) Replace all defective parts.

3-35. Assembly

a. Install the spray nozzle (8, fig. 3-21), orifice (4), and sleeve bushings (6) in the connecting rod (7).

b. Install the sleeve bearings (12) in the piston (15).

c. If new pistons or connecting rod bearings were installed, ream the new bearings in accordance with tolerances given in table 1-4.

d. Install the expander ring and oil rings (9), and the compression rings (10) on the piston (15) with a suitable tool. Position the rings so that the gaps are staggered around the piston.

e. Place the upper end of the connecting rod between the piston bosses, in line with the piston pin holes, and slide the piston pin (13) in position.

NOTE

The piston pin will readily slip into position, without forcing, if correctly fitted.

f. Install the piston pin retainers (14) at the exposed end of the piston pins. Repeat the procedure for all pistons and connecting rods.

g. Reassemble the remaining pistons and connecting rods in the same manner.

3-36. Installation

a. The lower end of each connecting rod and the connecting bearing caps are marked in sequence, through 3. These numbers identify the caps with the rods and show the particular cylinder with which each rod is used.

b. Be sure to position the piston rings so that the gaps are staggered 90° around the piston, then apply a film of clean engine oil to the piston, rings, and expander rings.

c. Install a ring compression tool on the piston, compressing the rings.

d. Rotate the crankshaft until the journal of the connecting rod is at the bottom of its travel, wipe the journal clean, and lubricate with engine oil.

e. Position the piston and connecting rod assembly, with the ring compression tool attached, on top of the cylinder block and aline with the cylinder sleeve. Line up the lower end of the connecting rod with the crankshaft and push the piston down into place.

f. Install the sleeve bearings (3) into the connecting rod bearing cap with the tang of the sleeve bearing in the cap groove.

g. Position the connecting rod bearing cap on the crankshaft and connecting rod. Secure the cap with two bolts (5), nuts (1), and cotter pins (2). Tighten the nuts to 65 to 75 ft-lb. torque.

h. Install the remaining pistons and connecting rods in the same manner as described in *a* through *g* above.

i. Install the lubricating oil pump (para 3-28).

j. Replace the oil pan (para 3-27).

k. Install the cylinder head (para 3-23).

Section VIII. AIR INLET HOUSING AND BLOWER HOUSING

3-37. General

a. The blower assembly supplies clean, fresh air to the engine combustion chamber for ignition and scavenges burned gases from the ignition chamber after combustion during the two-cycle operation. The source of the clean air is from the dry-type air cleaner via the air inlet housing which incorporates a control valve for emergency stopping and an additional screen (filter). The inlet from the air cleaner to the inlet housing is also connected to the cold weather starting aid system for injection of the highly-volatile fluid into the air system.

NOTE

The cleanest of air, to minimize wear of the cylinder liners, pistons and rings, requires frequent servicing of the air cleaner and periodic cleaning of the air inlet housing screen.

b. The air inlet housing is mounted on the blower housing and is readily removable. The blower assembly is mounted on the cylinder block, and is driven through a gear train from the engine. Uniform pressure from the blower is supplied by two hollow three-lobe, helical-type rotors, revolving at approximately twice the engine speed and space-controlled by timing gears.

3-38. Air Inlet Housing

a. Removal.

(1) Remove all air cleaner connection to the air inlet housing.

(2) Disconnect the emergency stop cable from the air valve lever (25, fig. 3-23).

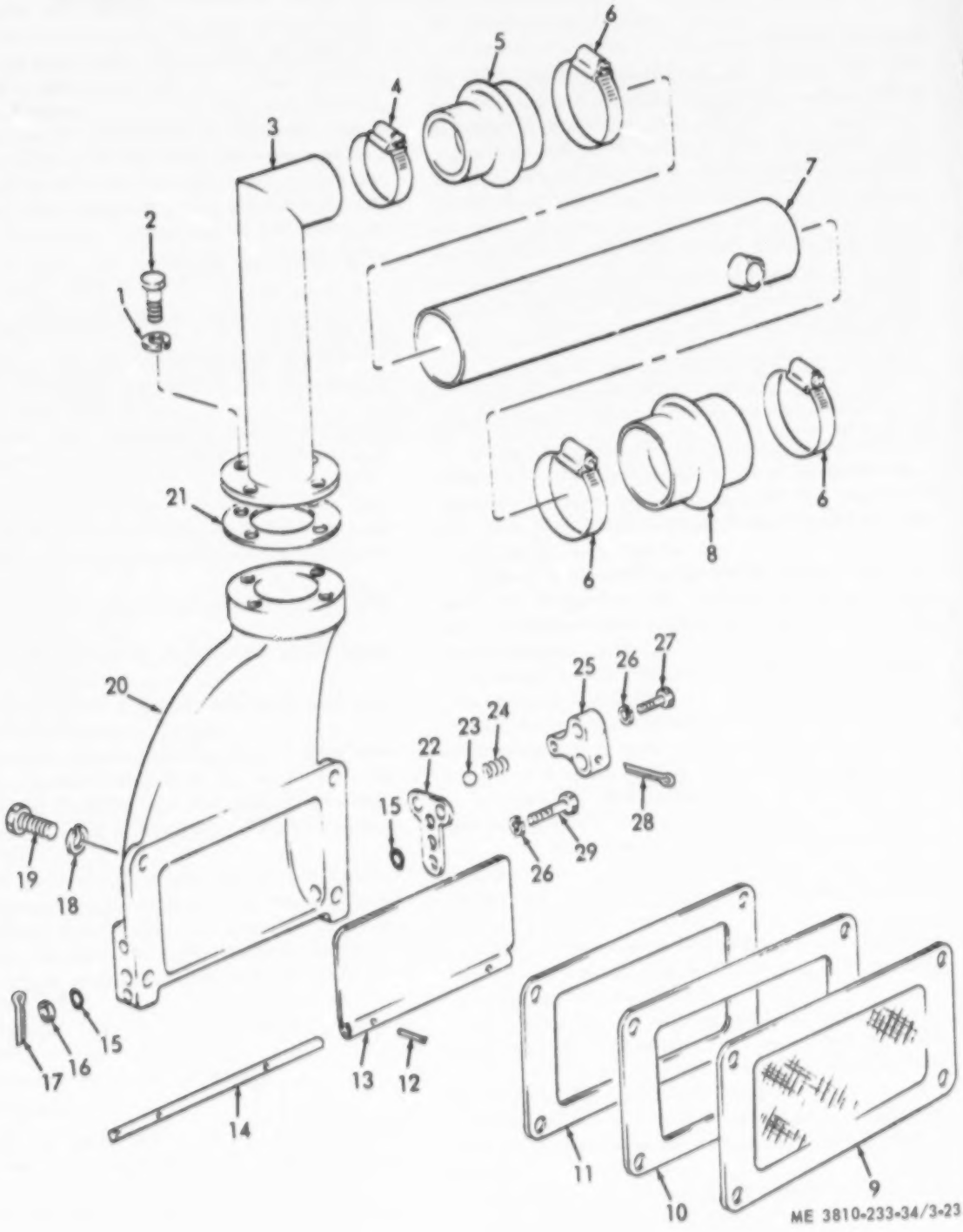


Figure 3-23. Air inlet housing assembly, exploded view.

Key to figure 3-23:

1 Lockwasher
2 Bolt
3 Tube
4 Clamp
5 Hose
6 Clamp (3)
7 Tube
8 Hose
9 Screen
10 Plate
11 Gasket
12 Pin
13 Valve
14 Shaft
15 Seal ring (2)
16 Washer
17 Cotter pin
18 Lockwasher
19 Bolt
20 Housing assy.
21 Gasket
22 Lockplate
23 Ball
24 Spring
25 Lever
26 Lockwasher
27 Bolt
28 Cotter pin
29 Bolt

(3) Remove the four bolts (19) and lockwashers (18) that secure the air inlet housing to the blower housing. Remove the housing assembly (20).

(4) Remove and discard the gasket (21).

b. Disassembly.

(1) Remove the cotter pin (28), capscrew (27), lockwasher (26), lever (25), spring (24), ball (23), lockplate (22), cotter pin (17), washer (16), and seal rings (15).

(2) Remove the screen (9), plate (10), and gasket (11).

(3) Remove the pins (12), shaft (14), and valve (13).

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent and dry thoroughly. Clean hoses with a cloth moistened with cleaning solvent.

(2) Clean the screen (9) thoroughly.

(3) Inspect all parts for wear, cracks, and deterioration. Replace as required.

d. Assembly. Assemble the air inlet housing in the reverse order of disassembly as outlined in *b* above.

e. Installation. Install the air inlet housing in the reverse order of removal as outlined in *a* above. Use a new gasket (21).

3-39. Blower Drive Assembly

a. General. The blower drive assembly is mounted in the blower drive gear support, and in addition to driving the blower, through interconnecting gearing, drives the governor, water pump, and fuel pump.

b. Removal.

(1) Remove the six bolts and lockwashers which secure the flywheel housing small cover.

(2) Remove the retaining ring that secures the blower drive shaft in the blower drive gear and remove the blower drive shaft assembly.

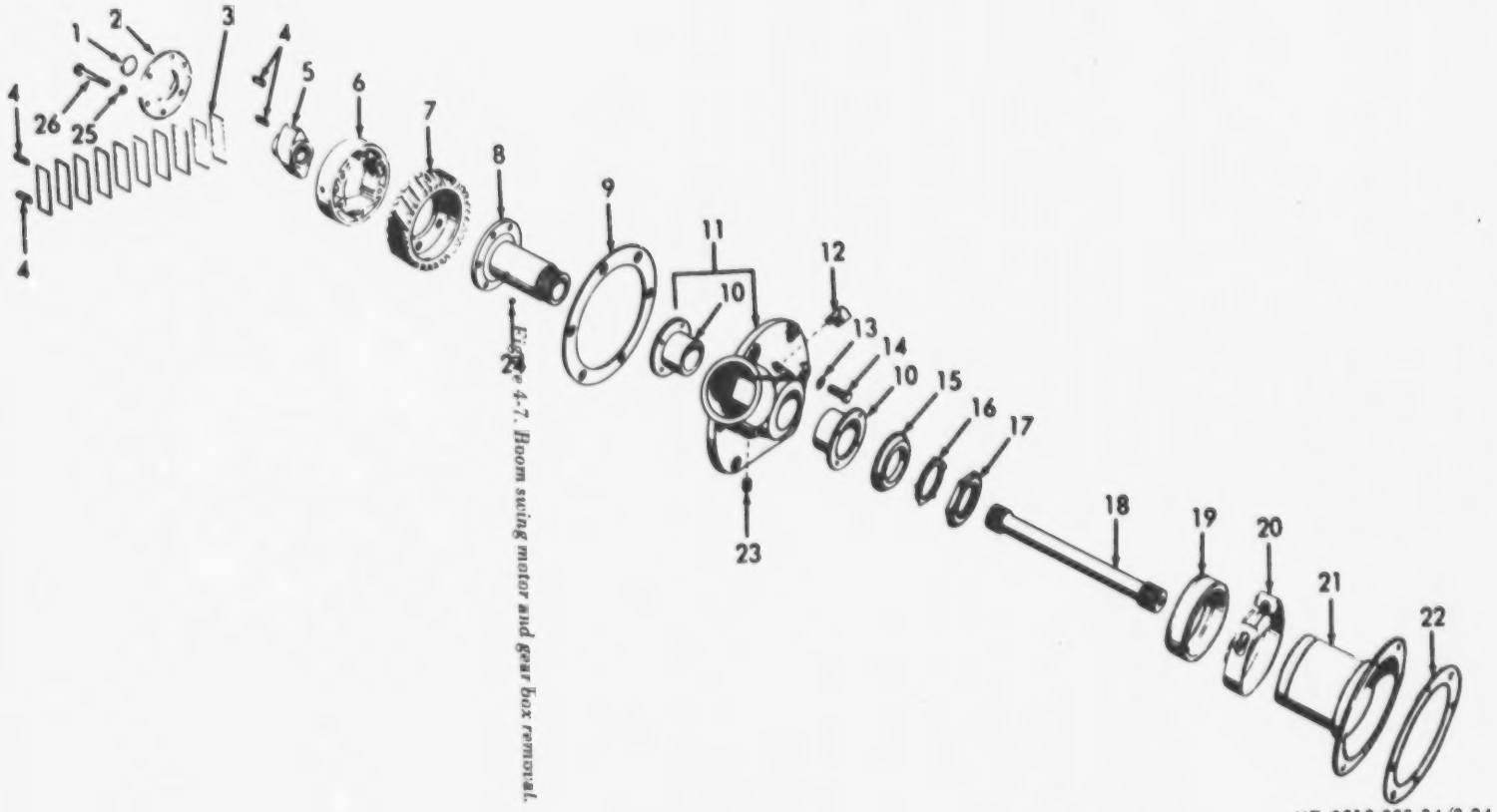
(3) Remove the blower assembly (para 3-40).

(4) Disconnect the blower drive oil line at the elbow (12, fig. 3-24).

(5) Straighten the ears on the lockwasher (16) and loosen the drive gear hub nut (17).

(6) Remove the two blower drive support and attaching capscrews (14) and lockwashers (13) and remove the support assembly (11).

(7) Withdraw the blower drive support assembly (11) from the cylinder block rear endplate. Discard the gasket (9).



1 Ring
2 Retainer
3 Spring pack
4 Seat
5 Cam
6 Support
7 Gear
8 Hub
9 Gasket
10 Bearing
11 Support assy.
12 Elbow
13 Lockwasher
14 Capscrew
15 Washer
16 Washer
17 Nut
18 Shaft
19 Seal
20 Clamp
21 Cover
22 Gasket
23 Plug
24 Ball
25 Lockwasher
26 Bolt

Figure 3-24. Blower drive, exploded view.

Figure 4-7. Boom swing motor and gear box removal.

c. Disassembly.

(1) Secure the blower drive gear and support assembly in a vise with protective jaws.

(2) Remove the drive coupling bolts (26) and lockwashers (25). Remove the retainer (2), ring (1), and coupling support (6).

(3) Remove the hub nut (17), lockwasher (16), lock ball (24), and thrust washer (15). Remove the blower drive gear hub (8).

(4) Press the gear (8) out of the blower drive gear (7).

d. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry with compressed air. Make sure all oil grooves, oil holes, and cavities are free from dirt.

(2) Replace thrust washers if they are worn or scored.

(3) If the bearings are worn or scored, the drive gear hub support or bearings will have to be replaced.

NOTE

The bushing-type bearings are diamond bored to an inside diameter of 1.6260-1.6265 inches. Clearance between new bearings and hub is 0.0010-0.0025 inches. The outer bearing is installed flush to 0.030 inch below the face of the support and the bearing on flywheel housing end protrudes 0.045-0.055 inch.

(4) If the serrations on the splined blower drive shaft (18) are worn, replace the shaft.

(5) Inspect the blower drive coupling support (6), cam (5), spring seats (4), and spring pack (3). Replace worn or damaged parts.

NOTE

New springs and seats are available as a kit.

(6) Inspect the blower drive gear (7). Replace if the teeth are scored, pitted or excessively worn.

e. Assembly.

(1) Secure the support assembly in a vise with protective jaws.

(2) Press the drive gear hub (8) into the drive gear (7).

(3) Lubricate all surfaces with clean engine oil.

(4) Place the thrust washer (15) on the protruding bearing on the flywheel side of the support and insert the hub and gear assembly.

(5) Insert the lock ball (24) in the drive gear hub and slide the thrust washer into position over the lock ball.

NOTE

Install the thrust washer with its tapered face towards the gear hub threads.

(6) Install a new lockwasher (16) and finger tighten the nut (17) on the hub. Install two bolts in the threaded holes in hub. Place a holding bar across the bolts to keep the hub from rotating and torque the nut (17) to 50-60 ft-lb. Bend the ears of the lockwasher over the nut and remove the two bolts.

(7) Place the drive coupling support (11) between two wood blocks.

(8) Install the spring end seats and spring seats in each corner of the drive coupling support.

(9) Lubricate the leaves of the spring pack with clean engine oil and insert them into the coupling support.

(10) Place the drive cam (5) on the end of the tapered installer tool (J-6270-07); insert the tapered end of the tool between the spring packs, and press the cam into position.

(11) Place the coupling support (6) against the drive gear (7) with the blower drive shaft (18) ring groove in the cam (5) facing away from the drive gear (7). Place the retainer (2) against the coupling support (6) when the flared edge of the retainer facing away from the support. Revolve the coupling assembly (11) on the hub (8) flange until the cam (5) lobes are in line with the oil grooves in the hub (8).

(12) Install the drive coupling bolts (26) and lockwashers (25).

f. Installation.

(1) Check the clearance between the gear hub and thrust washer before installing the drive gear and support assembly.

NOTE

Clearance limits are 0.0050-0.0080 inch.

(2) Install a new gasket (9) on the hub support.

(3) Attach the drive gear and support assembly to the cylinder block rear end plate.

(4) Connect the oil line.

(5) Install the blower (para 3-40).

(6) Install the blower drive shaft into the blower rotor gear hub (end without the groove ring must be inserted first). Secure the seal (19) and clamp (20).

(7) Lock the drive shaft in place with the retaining ring in the groove in the coupling cam.

(8) Install the flywheel housing small cover.

(9) Install the remaining bolts that secure the blower drive gear and support assembly.

3-40. Blower Assembly

a. Removal.

(1) Drain the water from the cooling system.

(2) Remove the limiting speed governor (para 3-44).

(3) Remove the water pump (TM 5-3810-233-12).

(4) Remove the fuel pump (para 3-42).

(5) Remove the air inlet housing (para 3-38).

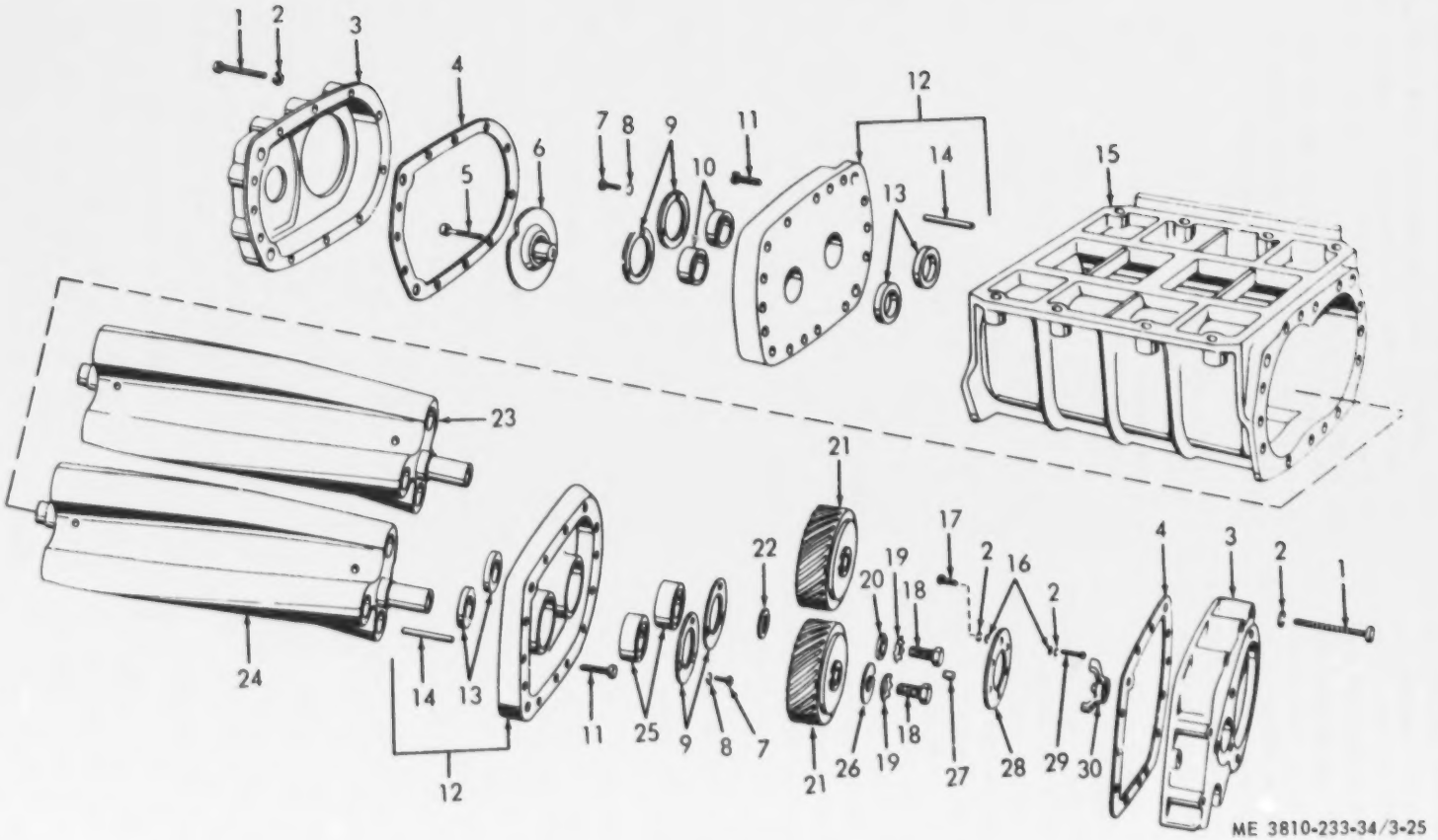
(6) Remove the blower drive shaft (para 3-39).

(7) Remove the four capscrews and washers that secure the blower assembly (fig. 3-25) to the cylinder block. Slide the blower slightly forward

and withdraw the blower drive shaft cover from the seal. Lift the blower assembly from the cylinder block and place the assembly on the workbench.

NOTE

Discard the gasket removed from between the blower housing and cylinder block.



1 Capscrew
2 Lockwasher
3 Cover
4 Gasket
5 Bolt
6 Coupling
7 Capscrew
8 Lockwasher
9 Retainer (2)
10 Bearing (2)
11 Bolt
12 Plate assy.
13 Seal (4)
14 Pin
15 Housing
16 Washer
17 Bolt
18 Capscrew (2)
19 Lockwasher (2)
20 Washer
21 Gear set
22 Shim
23 Rotor assy.
24 Rotor assy.
25 Bearing
26 Disk
27 Spacer
28 Plate
29 Bolt
30 Hub

Figure 3-25. Blower assembly, exploded view.

b. Disassembly.

(1) Remove the capscrews (1, fig. 3-25) and lockwasher (2) that secure the end covers (3) to the blower housing (15). Tap the ends of the covers with a soft hammer to loosen and remove from the housing. Remove and discard the gaskets (4).

CAUTION

Do not pry between the housing and end covers as this may damage the machined surfaces.

(2) Lock the rotors with a clean cloth and remove the bolt (5) from the blower rotor shaft and coupling (6) with a socket-head wrench. Pull the coupling from the shaft by threading a bolt into the tapped hole in the coupling.

(3) Remove the 3 bolts (29), lockwasher (2), and flatwashers (16) that secure the two gear hub plates (28) to the rear face of the blower upper rotor gear and remove the plates, gear hub (30), and gear hub spacers (27) from the gear. Separate the gear hub plates from the hub by removing the 3 bolts (17), lockwashers (2), and flatwashers (16).

(4) Remove the two screws (18), lockwashers (19), retaining washer (20), and blower rotor fuel pump coupling disk (26) from the blower rotor helical gears (21). Remove the two blower rotor helical gears at the same time and with the same puller as described in the removal of the end places and bearings below.

NOTE

Observe the number and thickness of shims of the rotor shaft. Remove the shims from the shaft and replace them accordingly when assembling the blower.

(5) Remove the three screws (7) and lockwashers (8) and remove the rear bearing retainer (9) from the housing plate assembly (12). Remove the other rear bearing retainer in the same manner.

(6) Remove the two front bearing retainers (9) in the same manner as described in (5) above.

(7) Remove the two bolts (11) from the front housing plate assembly (12).

(8) Release the rear housing plate assembly from the blower housing (15) by loosening the bolts (11) approximately three turns.

(9) Press the rotor shafts (23 and 24) from the bearings in the rear housing plate. Press the front housing plate, with rotor shafts still in the bearings, from the blower housing.

(10) Remove the housing plate assembly.

CAUTION

Inspect the rotors and blower housing to see if they are scored to the extent that removal of the front plate assembly and assembled rotors will further damage the rotors. If the rotors and blower housing are badly scored, the rotor shafts should be pushed from the bearings in the front plate assembly before removing the rotors as outlined above.

(11) Remove the rotors (23 and 24) from the plate assembly and bearings (25) with a suitable driving tool. Remove the bearings (10 and 25) from the plate assemblies. Drive the oil seals (13) from the plate assemblies (12).

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry with compressed air.

CAUTION

Do not use a wire brush or emery cloth. Handle blower parts carefully as aluminum parts are easily dented or burred.

(2) Inspect the inside of the blower housing and all finished surfaces for breaks, distortion, or damaged threads. Remove all rough spots or burrs with a fine mill file or scraper. Rephase all damaged threads. Replace a housing that is badly scored, warped, or cracked.

(3) Inspect the rotor lobes for smoothness. Inspect the rotor shaft serrations and bearing surfaces for wear or burrs. Remove all high spots and burrs from the rotors with a fine mill file or scraper. Replace rotor assemblies in a second condition, with a loose shaft, or badly worn shaft splines.

(4) When washed clean and lubricated with light oil, all bearings should roll smoothly. Replace loose, rough, or overheated bearings.

(5) The seal lip must be smooth, pliable, and leakproof. Replace all oil seals that have been removed from the plate assemblies or that are brittle, thin, or cut.

(6) Inspect the housing plate assemblies for cracks, breaks, distortion, or damaged threads. Inspect the finished surfaces of the housing plate assemblies to see that they are true, smooth, and unscored. Inspect the counterbores for the bearing and the bearing bosses to see that they are not worn excessively or scored. The bearings must fit the counterbore with a light push or tap fit. Remove all burrs or minor local score marks by filing or scraping carefully. Rephase all damaged threads. Replace housing plate assemblies that are cracked, badly scored, distorted, or have worn bearing counterbores.

(7) Inspect the gears for worn splines and cracked, broken, or worn teeth. Replace the gears if defective. The maximum allowable worn backlash for gears is 0.009 inch and minimum is 0.004 inch.

(8) Inspect all hardware for cracks, breaks, or damaged threads. Replace all damaged hardware.

(9) Clean old gasket material from all mating surfaces. Reassemble the blower with all new gaskets.

d. Assembly.

(1) Install the oil seals (13) in the housing plates (12).

(2) Insert the pins (14) in the blower housing (15). Mount the front housing plate in place with a soft hammer.

NOTE

Make sure the TOP mark on the outer ribbed side of the housing plate is at the top of the blower housing.

(3) Insert the two bolts (11) through the front housing plate assembly and thread into the blower housing (15). Tighten the screws securely and check for the required three-eights inch pin projection from the outer face of the housing plate assembly (12).

(4) Assemble the blower rotors (23 and 24) in the blower housing (15). Before continuing the reassembly, certain checking operations are necessary to insure the proper relation of parts. The lobe of one of the blower gears and the teeth on one of the timing gears form a right-hand helix; and, on the mating parts, a left-hand helix. The rotor with the right-hand helix must be used with the blower gear having the right-hand helical teeth. The rotor and gear with the right-hand helixs are the upper units in the blower. Those with the left-hand helixs are the lower units. One serration is omitted on the drive end of each rotor shaft and a corresponding serration is omitted in each gear. The gears must be assembled on the rotor shaft with the omitted serrations in alinement. The rotors are assembled in the blower housing with the omitted serrations toward the top on both rotor shafts.

(5) Start the front bearing (10) onto the forward end of the rotor shaft, with the numbered face of the bearing (extended outer race) facing out and away from the blower housing. Tap the front rotor bearing into the housing plate assembly with the bearing installing tool. Install the other roller bearing in the same manner.

(6) Secure the front rotor bearings in place with the two front bearing retainers (9), lockwashers (8), and screws (7).

(7) Start the two rear bearings (25) onto the serrated rotor shaft. Be sure the markings on the bearing races are facing out away from the blower housing. Assemble the bearings in the rear end plate assembly as described in (5) above.

(8) Secure the rear bearing in place with the two rear bearing retainers (9), lockwashers (8), and screws (7).

(9) Position the rear housing plate assembly (12) on the rotor shafts and secure with bolts (11). Measure the rotor-to-housing plate assembly clearances and rotor-to-housing clearance as instructed below.

(10) Install the blower rotor gear shims (22) on the rotor shafts. Replace the same number and thickness of shims as were removed in disassembly.

(11) Start the two blower rotor helical gears (21) onto the rotor shafts with omitted serrations on the shafts and gears registering. A center punch-mark in the end of each rotor shaft at the omitted serrations will assist in alining the gears on the shafts. Apply clean engine oil at the rotor shaft serrations and use the screws (18) and plain washers to hold the gears onto the upper and lower rotor shafts. Turn the screws into the shafts uniformly and draw the gears into position tight against the bearing races. Then remove the screws and washers.

CAUTION

The rotor gears must be pressed into position at the same time to avoid damage to gears and rotors. Do not pull the gears up tight if the rotors are in contact.

(12) Assemble the lockwasher (19) on the lower rotor gear retaining screw (18). Assemble the retaining washer on the upper rotor gear retaining screw (18). Install the screw (18) in the upper rotor gear and rotor shaft. Tighten the rotor gear screw to 25 to 30 ft-lb. torque.

(13) Secure the lower rotor gear to the rotor shaft by installing the blower rotor fuel pump coupling disk (30) on the screw (17) and lockwasher (2). Install the screw in the gear so the lugs of the disk engage the slots in the hub of the gear and the lockwasher gear engages the slot in the coupling disk. Tighten the rotor gear screw to 25 to 30 ft-lb. torque.

(14) After the blower rotors and gears have been installed, the blower rotors must be timed. The blower rotors should be positioned in the housing with a slight clearance between the lobes. This clearance may be varied by moving one of the helical gears in or out on the shaft, by adding or removing the blower rotor gear shims between the gear hub and bearing. If the upper rotor gear is moved out, the upper rotor will turn counter-clockwise when viewed from the gear end. If the lower rotor gear is moved out, the lower rotor will turn clockwise. This positioning of the rotor gear to obtain proper clearance between the rotors is known as blower timing.

(15) Measure the rotor clearance with a ½-inch-wide thickness gage. Measure from both the inlet and outlet sides of the blower, 1 inch from the front end of the blower, at the center of the rotors, and 1 inch from drive end of the blower. Insert the thickness gage through the air outlet side of the blower between the leading edge of the lower rotor and the trailing edge of the upper rotor. Time the rotors so there will be a minimum clearance of no

less than 0.002 inch and a maximum clearance of no more than 0.006 inch; then check the clearance between the leading edge of the upper rotor and the trailing edge of the lower rotor; minimum clearance is 0.014 inch.

(16) Having determined the amount one rotor must be revolved, to obtain the proper clearance, add the shims (22) back of either the upper or lower rotor gear. To do this, remove both rotor gears from the rotor shaft. Placing a 0.003-inch shim in back of the proper gear and draw the gears tightly into place. Remeasure the clearances between rotors. After the correct clearances are obtained, secure the rotor gears.

NOTE

Placing a 0.003 inch shim in back of a rotor gear will revolve the rotor 0.001 inch.

(17) Insert the thickness gage between the housing plate assemblies and the ends of the rotors. This operation must be performed at the ends of each lobe, making 12 measurements in all. The minimum clearance at the gear end should be 0.007 inch. The minimum clearance at the front housing plate assembly should be 0.009 inch.

(18) Measure the clearance between each rotor and the blower housing at both the inlet and outlet side, 12 measurements in all. Minimum clearance at the inlet side of the blower is 0.016 inch. Minimum clearance at the outlet side is 0.004 inch.

(19) Assemble the gear hub plates (28) on the gear hub (30) and secure with the bolts (17), lockwashers (2), and flatwashers (16). Position the gear hub plates on the outer face of the upper rotor gear, installing the gear hub spacers (27), between the plate and the face of the gear, and secure in place with the bolts (18), lockwashers (19), and flatwashers (20).

(20) Insert the splined end of the water pump shaft and coupling (4) into the front end of the blower lower rotor shaft. Secure the water pump shaft and coupling to the rotor shaft with the bolt (5).

(21) Cement the blower end plate cover gaskets (4) to the housing end plate assemblies.

(22) Secure the covers (3) to the blower housing with the screws (1) and lockwashers (2).

(23) Affix a new gasket (22, fig. 3-24) to the bolting flange of the blower drive cover (21) and assemble to the rear housing end plate cover with the six bolts and lockwashers, fingertight only.

CAUTION

Before installing the blower assembly to the cylinder block, examine the inside of the blower for any foreign material and revolve the rotors by hand, checking for smooth turning.

e. Installation.

(1) Position a new drive shaft cover seal (19, fig. 3-24) over the blower drive shaft cover (21).

(2) Install the hose clamp (20) over the drive shaft cover seal (19).

(3) Position the blower assembly on the cylinder block. Aline the splined drive gear shaft with the upper helical gear. It may be necessary to revolve the rotor slightly to engage the splines of the drive shaft with those of the gear hub. Secure the blower assembly to the cylinder block with the screws and lockwashers. Tighten the screws to 55 to 60 ft-lb torque.

(4) Slide the seal (19) and hose clamp (20) to a center position between the blower drive shaft cover and blower drive gear and tighten the hose clamp to seal the opening. Tighten the bolts to secure the blower drive cover to the housing end plate cover.

(5) Install the blower drive shaft, air inlet housing, fuel pump, water pump, and governor assembly in the reverse order of removal.

Section IX. FUEL PUMP ASSEMBLY

3-41. General

a. The fuel pump is of the positive displacement gear type. The pump is attached to the rear of the blower and is driven by the blower lower rotor. The pump gears have a pressed fit on the drive shaft. A spring-loaded relief valve, incorporated in the pump body, normally remains closed and opens only when the pressure in the pump rises above 65 psi. The fuel is then returned through a passages in the body from the pressure side to the suction side of the pump. Two oil seals are pressed into the bore in the flange side of the body with the feather-edge of the seals facing away from the fuel pump gears.

b. The fuel strainer and fuel filter are basically similar in design with the major difference being in the replaceable filter element. Fuel is drawn from the tank through the filter strainer by suction and supplied through the fuel filter to the fuel injectors under pressure. A check valve in the suction line to the fuel strainer prevents the return flow of fuel to the supply tank.

3-42. Fuel Pump

a. Removal and Disassembly.

(1) Remove the screws (5, fig. 3-26) that attach the fuel pump to the blower housing.

Remove the coupling fork from the fuel pump shaft (8).

(2) Remove the eight screws (14) and lockwashers (13) that secure the fuel pump cover (12) to the fuel pump body (6) and remove the cover.

(3) Remove the fuel pump shaft assembly (11) from the fuel pump body (6).

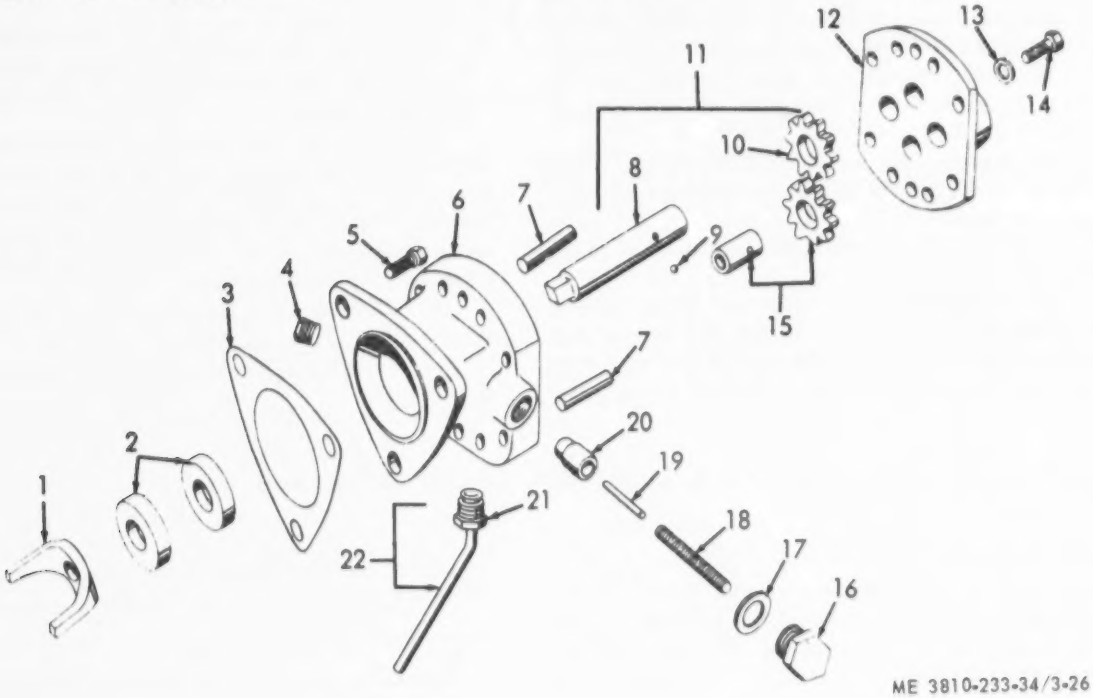
(4) Remove the spur gear (10) and bearing ball (9) from the fuel pump shaft (8).

(5) Remove the driven gear and shaft (15) from the fuel pump body.

(6) Remove the valve plug (16), gasket (17), pin (19), spring (18), and fuel valve (20) from the fuel pump body.

(7) Remove the two pins (7) from the fuel pump body.

(8) Drive or press the oil seals (2) from the fuel pump body.



1 Fork
2 Seal
3 Gasket
4 Plug
5 Screw
6 Body
7 Pin
8 Shaft
9 Steel ball
10 Gear
11 Shaft assembly
12 Cover
13 Lockwasher
14 Screw
15 Shaft assembly
16 Plug
17 Gasket
18 Spring
19 Pin
20 Valve
21 Inverted nut
22 Tube assembly

Figure 3-26. Fuel pump, exploded view.

b. Cleaning, Inspection, and Repair.

(1) Clean all the parts with an approved cleaning solvent and dry with compressed air.

(2) Inspect all parts for signs of excessive wear or scoring.

(3) Inspect the mating surfaces of the fuel pump body and the cover. They must be smooth and flat. Remove all nicks and burrs with a fine toothed file. Do not allow the file to mar the lapped surface as the slightest scratch will cause the pump to leak.

(4) Repair or replace all damaged parts in the fuel pump.

(5) Replace the oil seals at each disassembly of the fuel pump.

NOTE

A fuel pump overhaul kit which contains oil seals, gaskets, shaft and gear assemblies, and relief valve parts is available.

c. Assembly and Installation.

(1) Place one oil seal (2) on the oil seal in-

staller handle with the sealing edge against the shoulder of the handle.

(2) With the oil pump body (6) supported on wooden blocks, insert the pilot of the oil seal installer into the pump so the seal starts straight into the pump flanges. Then drive the seal into place in the counterbore of the flange until it bottoms.

(3) Install the oil seal installer adapter on the oil seal installer handler. Position the other seal (2) on the installing tool with the sealing edge facing the adapter. Insert the pilot of the installer handle into the oil pump body (6) so the seal starts straight into the pump flange and drive the seal into the pump body until the shoulder of the adapter contacts the body.

(4) Reassemble the relief valve in the pump body by installing the fuel valve (20), spring (18), pin (19), gasket (17), and secure with the valve plug (16). Install the two pins (7) in the fuel pump body (6).

(5) Install the driven gear and shaft (15) in the pump body with the camfered end of the gear teeth facing the pump body. Install the spur gear (10) over the squared end of the fuel pump shaft (8), with the slot in the gear facing the plain end of the shaft. Press the gear beyond the bearing ball retaining hole. Press the bearing ball (9) in the hole and press the gear back until the end of the slot contacts the ball.

(6) Lubricate the fuel pump shaft and insert the squared end of the shaft into the opening at the gear side of the pump body and through the two oil seals (2).

CAUTION

Coat the face of the pump cover with a very light coat of sealant, being careful to keep the sealant out of the gear compartment.

(7) Lubricate the gears and shaft with clean engine oil, then position the fuel pump cover (12) against the pump body (6) with the two pins (7) in the pump body entering the holes in the cover, and secure the cover to the body with the eight lockwashers (13) and capscrews (14).

(8) Position the coupling fork (1) on the squared end of the fuel pump shaft (8).

(9) Install the fuel pump in the reverse order of removal.

Section X. LIMITING SPEED GOVERNOR

3-43. General

Some method of controlling engine speed created by fluctuating loads is required, and to accomplish this, a governor is introduced into the linkage between the throttle control and fuel injectors. The governor is mounted on the front end of the blower, and is driven by the upper blower rotor. The limiting speed governor, is a double-weight type of design which controls the lower and upper speeds (450-550 rpm—2300 rpm) of the engine (fig. 3-27).

NOTE

Remember, that due to the shuttle-throttle-linkage incorporated in this installation, the governor control can be bypassed by the crane operator.

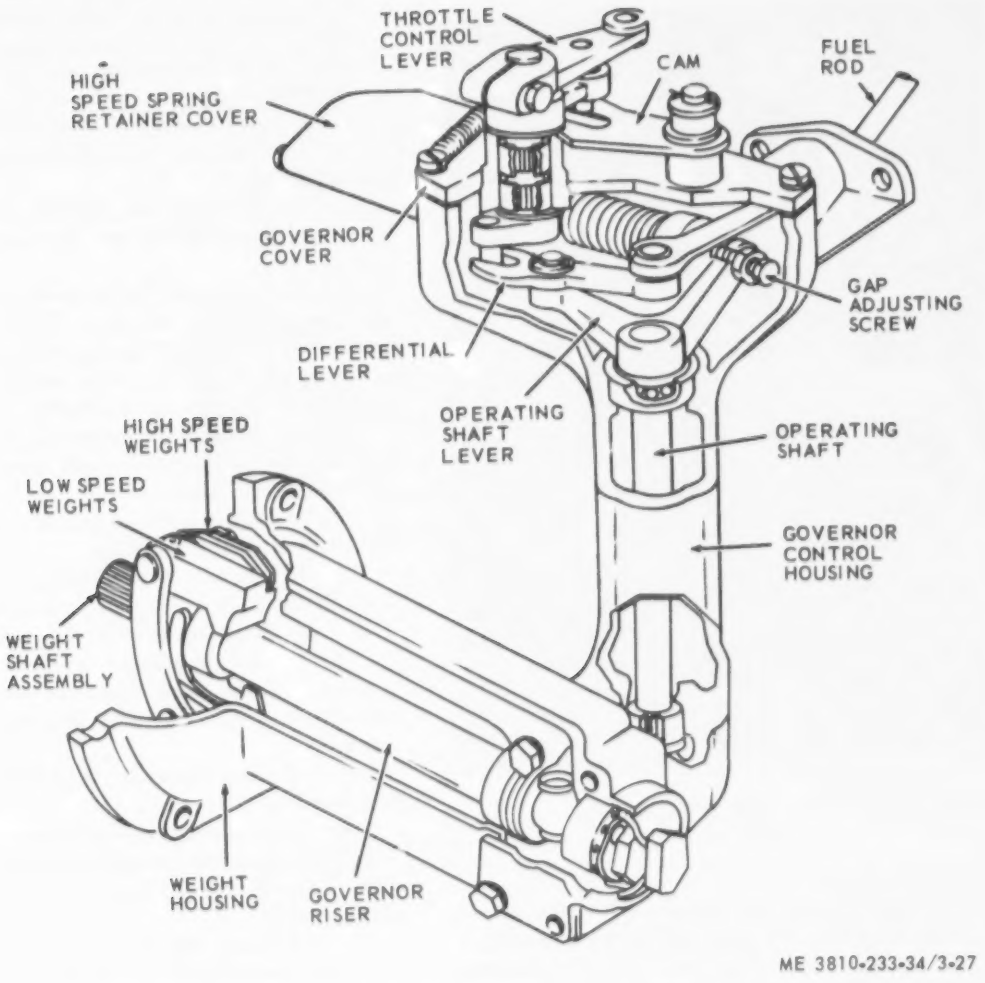


Figure 3-27. Limiting speed governor, cross-section view.

3-44. Governor Removal and Disassembly

NOTE

Before deciding that a defective governor is causing the malfunction, check all injector control linkage and system components to insure that they are functioning properly.

a. Removal.

(1) Disconnect the engine shutdown control wire and throttle linkage attached to speed control lever (fig. 3-28).

(2) Remove the rocker cover.

(3) Remove two screws and breather tube (fig. 3-28).

(4) Remove four screws, lockwashers, governor cover and gasket from the governor control housing.

(5) Disconnect fuel rod (fig. 3-9) from injector control tube lever and differential lever (fig. 3-9).

(6) Remove four bolts and separate the cover from the weight housing (fig. 3-28).

(7) Remove the two governor-to-cylinder head bolts.

(8) Move the upper end of the control housing away from the cylinder head and free the lower end from the weight housing.

(9) Remove the six governor weight housing-to-blower bolts and withdraw the housing from the blower.

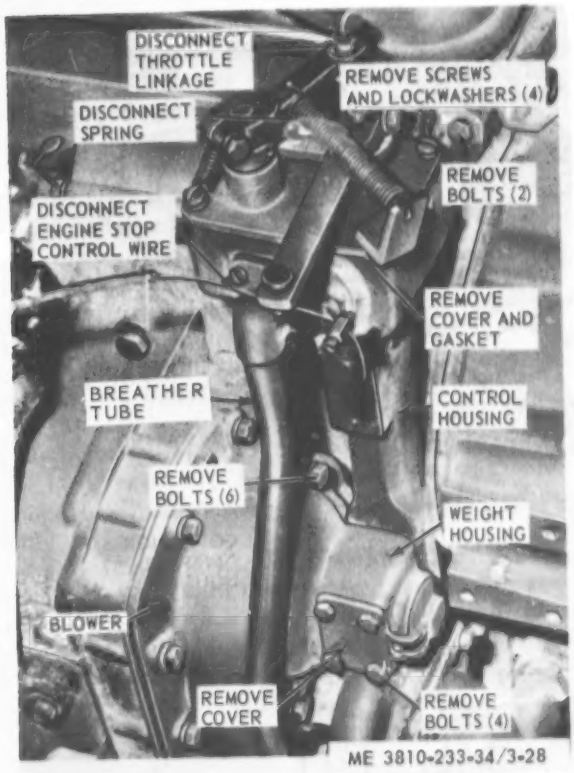


Figure 3-28. Limiting speed governor, removal and installation.

b. Disassembly.

(1) *Disassemble the governor housing cover.*

(a) Remove the four screws (7, fig. 3-29) and lockwashers (2) that attach the governor housing cover to the governor body. Lift the governor cover and gasket from the governor housing.

NOTE

Before removing any parts from the governor, wash the entire unit with an approved cleaning solvent and dry thoroughly with compressed air. Inspect the assembly for worn or damaged parts which may be replaced without complete disassembly of the unit.

(b) Loosen the screw (1, fig. 3-29) and lift the speed control lever (3) from the throttle shaft (9).

(c) Remove the tapered pin (15) from the stop lever (13). Lift the lever and retainer (14) from the throttle shaft (9) and withdraw the shaft from the cover.

(d) Remove the spring retainer (4) and washer (5). Remove the cam (6) and stop lever (13). Remove the seal (12).

NOTE

At this point, inspect the needle bearings for wear or damage. If satisfactory, do not remove. Otherwise, press out the old bearings and replace with new bearings.

(2) *Disassemble the governor control housing.*

(a) Place the control housing in a vise with protective jaws.

(b) Remove the screws (1), lockwashers (2), high-speed spring retainer housing (3), and gasket (4).

(c) Loosen the locknut (51) and remove the high-speed spring retainer (52), idle adjusting screw (6), high-speed spring (50), spring plunger (49), low-speed spring (54), spring seat (53), and spring cap (55) as an assembly.

(d) Remove retaining ring (10), washer (9) and lift the differential shaft lever (8) from the operating shaft lever (7).

(e) Remove the expansion plug (23) from the bottom of the housing.

(f) Remove the bearing retaining screw (13), flatwasher (12), and lockwasher.

(g) Support the control housing bottom side up. Press the operating shaft (16) from the operating fork (61). Remove the shaft (16), operating lever (7), and bearing (14) as an assembly.

(h) Press the shaft (16) from the lever (7) and bearing (14).

(3) *Disassemble the governor weight housing.*

(a) Place the weight housing (45) in a vise with protective jaws. Remove the cap (24) and gasket (25).

(b) Straighten the tang of the lockwasher (27) and remove the screw (26).

(c) Thread a 5 / 16-24 by 3-inch bolt into the tapped end of the weight shaft (41) and press the shaft from the bearing (28).

(d) Remove the riser thrust washer (29) and governor riser (43) from the shaft (41).

(e) Remove the bearing (28) from the weight housing.

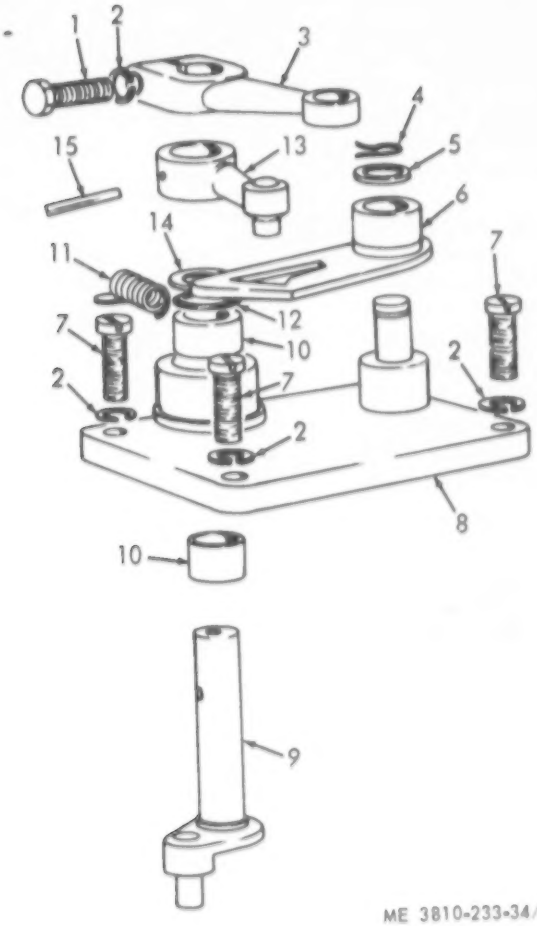
(f) Mark the weights (34 and 37) and the carrier (42) with a center punch for identification; and to facilitate assembly. Also note the position of the thin washers (36) between the weights so that the parts can be replaced in their original position.

(g) Remove the setscrew (35) and the pins (39). Remove the weights (34 and 37).

NOTE

The bushings (38) in the high speed weights (37) may be replaced at this time if necessary.

(h) Remove the weight carrier (42), if necessary, by pressing from the weight shaft (41).



1 Screw
2 Lockwasher
3 Throttle shaft lever
4 Retainer
5 Washer
6 Cam
7 Screw
8 Cover assembly
9 Shaft assembly
10 Bearing
11 Spring
12 Seal
13 Stop lever
14 Retainer
15 Pin

Figure 3-29. Governor cover, exploded view.

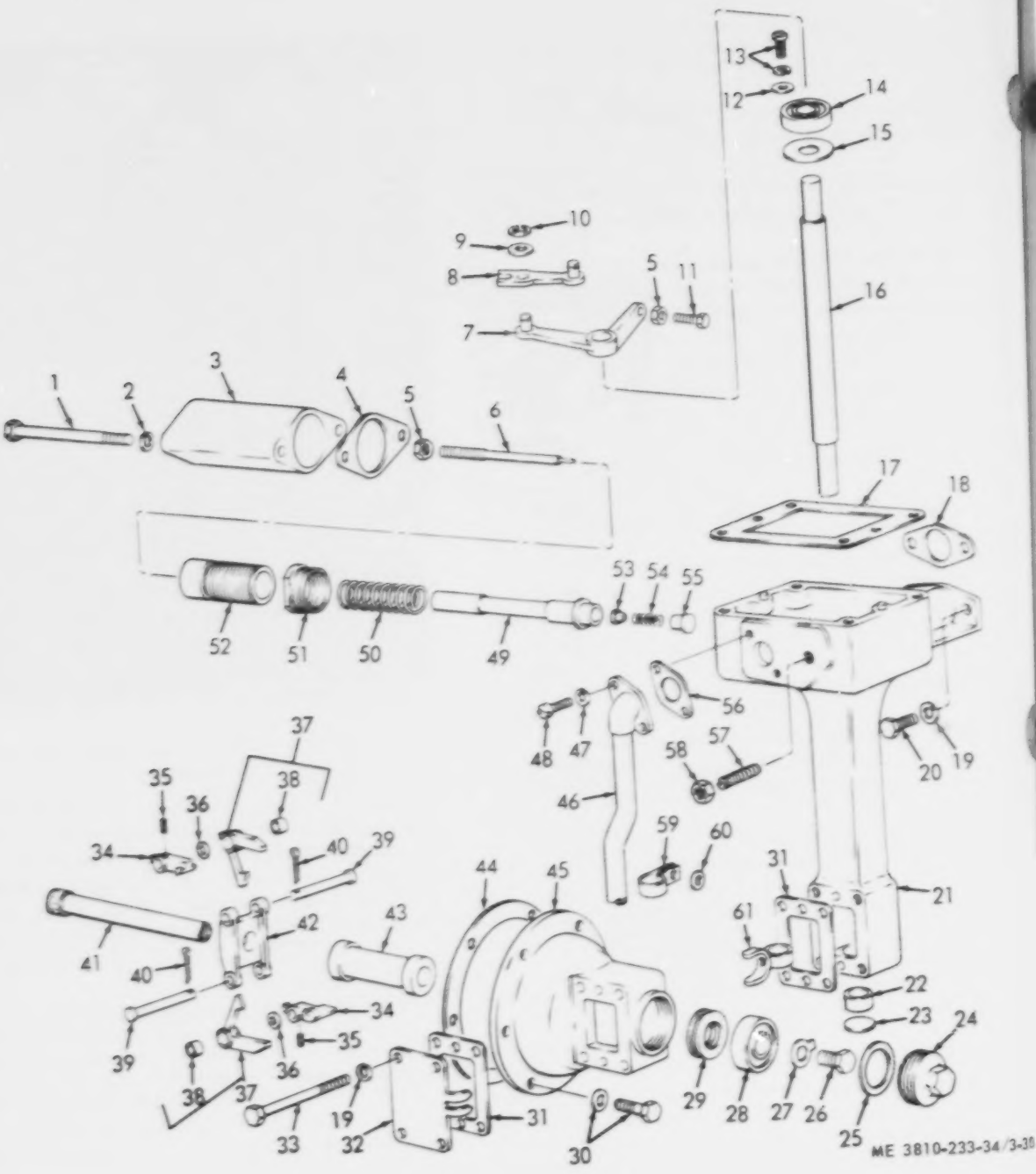


Figure 3-30. Governor assembly, exploded view.

Key to figure 3-30:
1 Screw (2)
2 Lockwasher (2)
3 Spring housing
4 Gasket
5 Nut (2)
6 Adjusting screw
7 Lever
8 Lever assy.
9 Washer
10 Retaining ring
11 Screw
12 Washer
13 Screw w / lockwasher
14 Bearing
15 Washer
16 Shaft
17 Gasket
18 Gasket
19 Lockwasher (6)
20 Screw
21 Governor housing
22 Bushing
23 Expansion plug
24 Cap
25 Gasket
26 Screw
27 Lockwasher
28 Bearing
29 Thrust bearing
30 Screw w / seal washer (6)
31 Gasket (2)
32 Cover
33 Screw (4)
34 Weight (low speed) (2)
35 Setscrew (2)
36 Washer (4)
37 Weight assy. (high speed) (2)
38 Bushing (2)
39 Pin (2)
40 Cotter pin (2)
41 Shaft
42 Carrier
43 Riser
44 Gasket
45 Housing, weight
46 Breather tube
47 Lockwasher (2)
48 Screw (2)
49 Plunger
50 Spring (high speed)
51 Locknut
52 Spring retainer
53 Seat
54 Spring (low speed)
55 Cap
56 Gasket
57 Screw
58 Nut
59 Clip
60 Washer
61 Fork

3-45. Cleaning, Inspection and Repair

a. Immerse all governor parts in an approved cleaning solvent to loosen and remove all dirt and foreign material.

b. Use a stiff bristle brush and compressed air to assure absolute cleanliness of all parts. Dry thoroughly with compressed air.

c. Inspect all bushings and bearings to be sure that they are free from corroded or pitted surfaces. Remove the bearings slowly by hand to detect any signs of roughness.

d. Inspect shafts for flat spots or excessive wear. Replace as required.

CAUTION

All moving parts in the governor assembly must operate freely and without binding, yet excessive play must be avoided. Careful inspection is mandatory, and all doubtful components must be replaced if the assembly is to be adjudged satisfactory in operation when replaced.

e. Assemble the low and high speed weights and check for freedom of movement.

3-46. Assembly and Installation

a. Assembly.

(1) Assemble the governor housing cover in the reverse order of disassembly (para 3-44*b*).

(2) If the throttle shaft bearings (10, fig. 3-29) in the housing require replacement, the lower bearing must be flush with the lower end of the bearing boss. The upper bearing must be pressed in $\frac{1}{8}$-inch below the surface of the upper bearing boss.

NOTE

Lubricate all parts with clean engine oil before assembling.

(3) Assemble the governor control housing in the reverse order of disassembly (para 3-44*b*(2) above).

NOTE

Apply sealant to the expansion plug (23, fig. 3-30) before installing.

(4) Assemble the governor weight housing assembly in the reverse order of disassembly (para 3-45*b*(3) above).

NOTE

The bearing (28) has thrust capacity in one direction only. Install so that the thrust shoulder faces the governor weights.

b. Installation. Refer to figure 3-28 and install the governor as follows:

(1) Affix a new gasket to the governor weight housing.

(2) Start the splined end of the weight shaft in the upper blower rotor and position the housing against the blower end plate.

(3) Place a new copper gasket on each of the six weight housing-to-blower bolts and thread the bolts into the end plate. Tighten with fingers only.

(4) Place a new gasket over the dowels and against the side of the weight housing facing the engine.

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(5) Position the lower end of the control housing over the dowel pins in the weight housing.

(6) Use a new gasket and attach the control housing to the cylinder head with two bolts. Tighten the bolts.

(7) Tighten the six governor-to-blower bolts.

(8) Use a new gasket and replace the weight housing cover.

(9) Replace the fuel rod on the differential lever pin and the injector control tube lever (fig. 3-9).

(10) Place a new gasket on the governor control housing and mount the cover housing with the four screws (fig. 3-28).

NOTE

Make sure that the pin on the throttle shaft is registered in the slot in the differential lever.

(11) Install breather tube.

c. Adjustment. Adjust the governor as instructed in paragraph 3-21.

Section XI. AIR COMPRESSOR AND DRIVE COUPLING

3-47. General

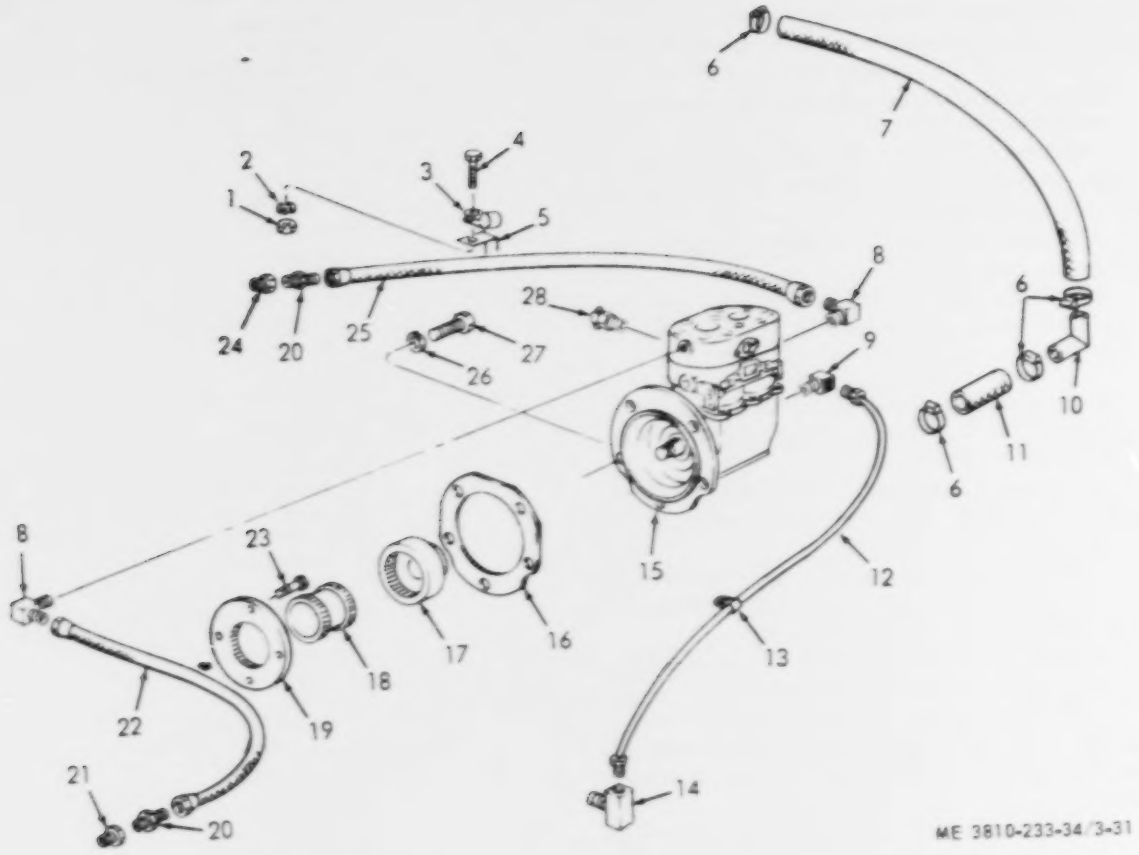
The air compressor is a piston-type, water-cooled unit which provides 12 cubic feet of air per minute at a pressure of 120 pounds per square inch. A minimum of four minutes engine operation is required to reach the proper crane operating pressure. A self-contained unloader mechanism, controlled by a governor, permits continuous running of the compressor by an accessory drive coupling attached to the engine camshaft gear. The compressor is lubricated by the engine lubricating oil; supplied by an external oil line from the engine block, with return through a passage in the compressor mounting flange.

3-48. Air Compressor Removal and Disassembly

a. Removal.

(1) Disconnect hose and lines to the air compressor (fig. 3-31).

(2) Remove four mounting bolts (27, fig. 3-31) and lockwashers (26). Remove the compressor assembly (15).



1 Nut
2 Lockwasher
3 Clamp
4 Screw
5 Bracket
6 Clamp
7 Hose
8 Elbow (2)
9 Elbow
10 Elbow
11 Hose
12 Tube assy.
13 Clamp
14 Tee
15 Compressor assy.
16 Gasket
17 Hub
18 Coupling
19 Drive plate
20 Adapter (2)
21 Reducer
22 Hose assy.
23 Shouldered screw
24 Reducer
25 Hose assy.
26 Lockwasher
27 Screw
28 Draincock

Figure 3-31. Compressor drive, coolant and oil lines, exploded view.

b. Disassembly.

NOTE

Before disassembly, the cylinder head, cylinder block and crankcase should be marked to maintain their relationship upon reassembly.

(1) Remove 10 capscrews (2, fig. 3-32) and remove the cylinder head (4), discarding the gasket (5).

(2) Remove discharge valve cap nuts (3) and lift out discharge valve springs (48) and valves (47).

NOTE

Discharge valve seats (46), inlet valve spring inserts (50), and inlet valve spring seats (49) can be removed, but it is not necessary unless they are badly worn or damaged. The discharge valve seat is a threaded fit, while the inlet valve spring insert and seat are pressed into the cylinder head.

(3) Lift inlet valve springs (51) and inlet valves (52) from their guides in the block.

(4) Remove five capscrews (32), lockwashers (33), and the machine screw (31), and remove the base cover (30), discarding the gasket (29).

(5) Straighten the tangs of the lockwashers (24) and remove bolts (25), lockwashers (24), bearing caps (23), and lower bearing shells (22).

NOTE

Be sure to keep bearing caps with their respective connecting rods.

(6) Push pistons with connecting rods attached out the top of the cylinder block, removing the upper bearing shells (14).

(7) Use a suitable expander tool and remove the piston rings (9).

(8) Remove wrist pin lock wires (12), and press wrist pins (10) from the piston (11) and connecting rod (13).

NOTE

Wrist pin bushings (62) should be removed only if warranted by inspection as outlined in inspection paragraph following.

(9) Remove nut (34), hub (17, fig. 3-31), and machine key (59, fig. 3-32) from drive end of crankshaft.

(10) Remove capscrews (16), lockwashers (15), end cover (17), and preformed packing (19) from crankcase. Remove plug (18).

(11) Press crankshaft (26) from crankcase, removing thrust washers (21 and 27).

(12) If necessary as a result of inspection, bushing (35) can be pressed from crankcase (28), and bushing (20) may be pulled from end cover (17).

(13) Remove two capscrews and lockwashers that secure the governor to the rear of the cylinder block. Discard the gasket.

(14) Remove two capscrews (61), lockwashers (60), and air strainer (58) from cylinder head. Remove and discard the strainer gasket.

(15) Depress and remove unloader spring (56), spring seat (55), and spring saddle (57) from cylinder block.

(16) Lift unloader plungers (45) and guides (54) from the cylinder block. Use compressed air, applied to the rear port exposed by removal of the governor assembly, to blow unloader pistons (43) from piston bores. Remove grommet and back-up ring (44) from piston.

(17) Remove inlet valve guides (53).

NOTE

Inlet valve seats (42) and unloader bore bushings (41) should only be removed if replacement is necessary.

(18) Remove capscrews (39) and lockwashers (38) to separate cylinder block (40) from crankcase (28). Discard gasket (36).

(19) Remove pipe plug (37) and any other plugs to facilitate thorough cleaning of passageways.

Key to figure 3-32:

1 Pipe plug
2 Capscrew
3 Discharge valve capnut
4 Cylinder head
5 Gasket
6 Gasket
7 Stud
8 Nut
9 Piston rings
10 Wrist pin
11 Piston
12 Lockwire
13 Connecting rod
14 Upper bearing shell
15 Lockwasher
16 Capscrew
17 Cover
18 Pipe plug
19 Gasket
20 Bushing
21 Thrust washer
22 Lower bearing shell
23 Bearing cap
24 Lockwasher
25 Bolt
26 Crankshaft
27 Thrust washer
28 Crankcase
29 Gasket
30 Cover
31 Machine screw
32 Capscrew
33 Lockwasher
34 Nut
35 Bushing
36 Gasket
37 Pipe plug
38 Lockwasher
39 Capscrew
40 Cylinder block
41 Bushing
42 Valve seat
43 Piston
44 Back-up-ring
45 Unloader plunger
46 Discharge valve seat
47 Discharge valve
48 Discharge valve spring
49 Inlet valve spring seat
50 Inlet valve spring insert
51 Inlet valve spring
52 Inlet valve
53 Inlet valve guide
54 Unloader plunger guide
55 Unloader spring seat
56 Unloader spring
57 Unloader spring saddle
58 Air strainer
59 Key
60 Lockwasher
61 Capscrew
62 Bushing

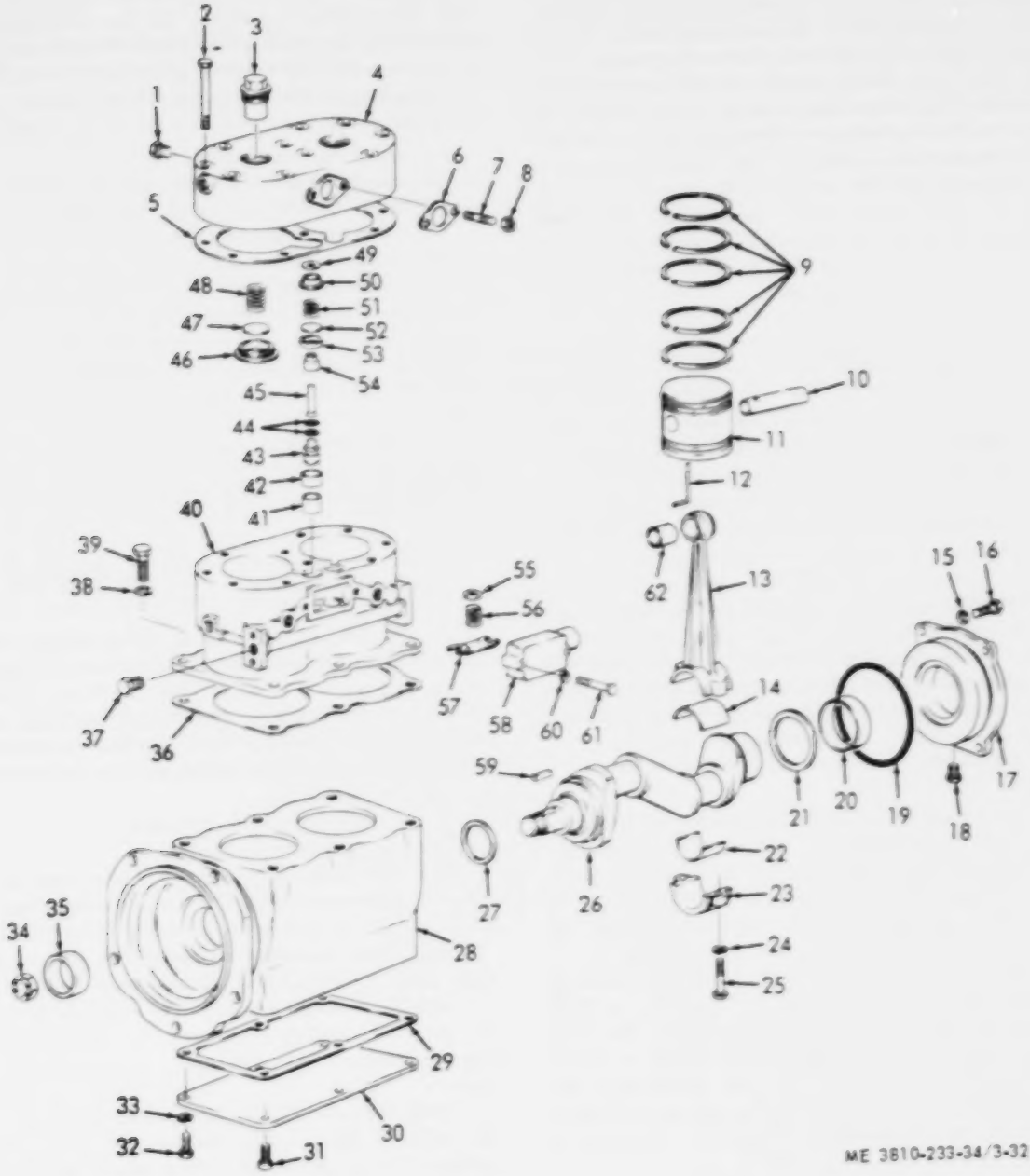


Figure 3-32. Air compressor assembly, exploded view.

3-49. Cleaning, Inspection, and Repair

a. Clean all parts with an approved cleaning solvent and dry with compressed air.

b. Remove all carbon deposits from discharge passages and all rust and scale from cooling passages of cylinder head (4). Plug all but one port to the cooling passages. To the remaining port, apply a source of compressed air. Immerse entire cylinder head in water. If a steady stream of bubbles is detected, replace cylinder head.

c. Assemble discharge valves (47), with new springs (48) and new valve caps (3) into cylinder head. Valve travel should be between 0.056-0.070 inch. Apply 100 pounds of air pressure through cylinder head discharge port and apply soapy water at the discharge valves and seats. A slight leakage is permissible. If leakage is excessive, continue to apply air pressure, and with a fiber or hardwood dowel and hammer, tap the valves off their seats several times. This should help seat the valves.

and reduce any leakage. If excess leakage continues, the valve seats can be dressed by lapping with a suitable stone. Repeat test above. If excessive leakage persists, replace valve seats (46) and valve (47). With air pressure still applied to the cylinder head, check for leakage at the discharge capnuts (3). No leakage at this point is permissible.

d. Clean carbon and dirt from inlet and unloader passages of cylinder block (40).

e. If inlet valve seats show signs of slight damage, they can be dressed with fine emery cloth or a lapping stone. A seat that is damaged excessively should be replaced.

NOTE

The dimension from the top of the cylinder block (40) to the inlet valve seat (42) should not exceed 0.145 inch nor be less than 0.101 inch.

f. Replace worn or damaged inlet valves (52).

g. Check unloader bore bushings (41) for wear, rust or damage. If bushings are to be replaced, run a ⅛-inch pipe tap inside the bushing, then insert a ⅛-inch pipe threaded rod and pull the bushing straight up and out.

CAUTION

Do not use an "easy-out" for removing unloader bore bushings

h. Cylinder bores which are scored, out of round by more than 0.002 inch or tapered more than 0.003 inch should be rebored or honed oversize.

NOTE

Clearance between pistons and cylinder bores should be 0.002—0.004 inch.

i. Check pistons for scores, cracks, or enlarged ring grooves. Replace a piston that is scored, cracked, or has enlarged ring grooves. Measure each piston with a micrometer in relation to its respective cylinder bore to be sure it fits to clearances given in note above.

j. Wrist pins should be a light press fit in pistons. If wrist pin is loose fit, the pin, piston, or both should be replaced. With piston, wrist pin, and connecting rod assembled, rock the piston to check clearance between wrist pin and connecting rod bushing. Clearance should not exceed 0.0015 inch. Replace wrist pin bushings if excessive clearance is found.

NOTE

Wrist pin bushings should be reamed after being pressed into connecting rod, to a clearance of 0.0001—0.0006 inch on the wrist pin.

k Check main bearings (20 and 35) for wear or flat spots. Replace a worn or damaged bearing.

NOTE

Clearance between main bearings and crankshaft journals should be 0.002—0.004 inch.

l. Check clearance of connecting rod bearing shells (14 and 22) on crankshaft journals. The clearance must not be less than 0.0003 inch or more than 0.0021 inch after rebuilding.

3-50. Assembly and Installation

a. Assembly. Assembly of the compressor assembly is essentially the reverse of disassembly, *b* above, with the following special instructions.

(1) Use a new cylinder block gasket (36) when assembling the cylinder block to crankcase.

NOTE

Be sure the relationship of the cylinder block to crankcase is the same as before disassembly.

(2) Use a new gasket (19) when installing end cover (17) on crankcase.

(3) Press wrist pin (10) into piston (11) and connecting rod (13) so that the lockwire hole in the pin alines with that of the piston. Install new lockwires (12) through piston and wrist pin and snap short end into hole provided at the bottom of the piston.

(4) Install piston rings (9) on piston with beveled edge toward the top of the piston. Stagger the ring gaps by at least 90 degrees.

NOTE

Piston rings should have a groove clearance of 0.002—0.004 inch. Gap clearance with ring installed on piston should be 0.005—0.015 inch.

(5) Lubricate the piston, piston rings, wrist pin, and connecting rod bearings with clean engine oil and insert assembly through the top of the cylinder block. Position the bearing cap (23) and using new lockwashers (24) tighten bolts (25) evenly and bend lockwasher tangs up against the hex head of the bolt.

(6) Install the other connecting rod and piston assembly in the same manner.

(7) The unloader pistons (43) and their bores must be lubricated with lubricant conforming to FED. SPEC. VV-D-1078 prior to installation.

(8) There should be a loose sliding fit between inlet valve guides (53) and the valves (52).

(9) If discharge or inlet valve seats (46 and 42) were repaired or new one's installed, be sure they fit within clearances given in paragraph *e* above.

(10) Before assembling cylinder head (4) to the cylinder block (40), secure the inlet valve springs (51) to the head with a small amount of grease.

(11) Place a new cylinder head gasket (5) on the block and carefully aline the cylinder head assembly on block. Tighten capscrews (2) evenly.

(12) Use the new gaskets when installing air strainer (58) and governor to cylinder block.

(13) Use a new gasket (29) when installing base cover (30). Note the location of machine screw (31), in securing cover to crankcase.

b. Installation.

(1) Install compressor (15, fig. 3-31), using new gasket (16).

(2) Install mounting bolts (27), and lockwashers (26).

(3) Connect hoses and lines. Tighten connections firmly but do not overtighten.

3-51. Accessory Compressor Drive Coupling

a. Removal.

(1) Remove the air compressor (para 3-48).

(2) Remove nut (34, fig. 3-32) and remove hub (17, fig. 3-31) from compressor assembly.

(3) Remove coupling (18).

(4) Remove four capscrews (23) and remove adapter plate (19) from camshaft gear.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry with compressed air.

(2) Inspect hub, coupling, and adapter plate for wear, cracks, or missing teeth.

(3) Replace a hub, coupling, or adapter plate that is worn, cracked, or is missing teeth.

c. Installation. Coat all parts with clean engine oil and install in reverse of instructions in paragraph *a* above.

Section XII. RADIATOR, FAN ASSEMBLY, WATER PUMP, AND WATER MANIFOLD

3-52. General

The cooling system employs a radiator; cooling fan driven from the crankshaft pulley; water pump driven from the lower blower rotor, and a water outlet manifold.

3-53. Radiator

a. Removal.

(1) Drop engine side panels and remove hinged top hood (TM 5-3810-233-12).

(2) Remove the starting aid pressure cylinder, cylinder retaining bracket, and control valve bracket from the radiator support bracket (TM 5-3810-233-12).

(3) Open drain cock and drain radiator.

(4) Loosen hose clamps and slide upper and lower hose from radiator connections.

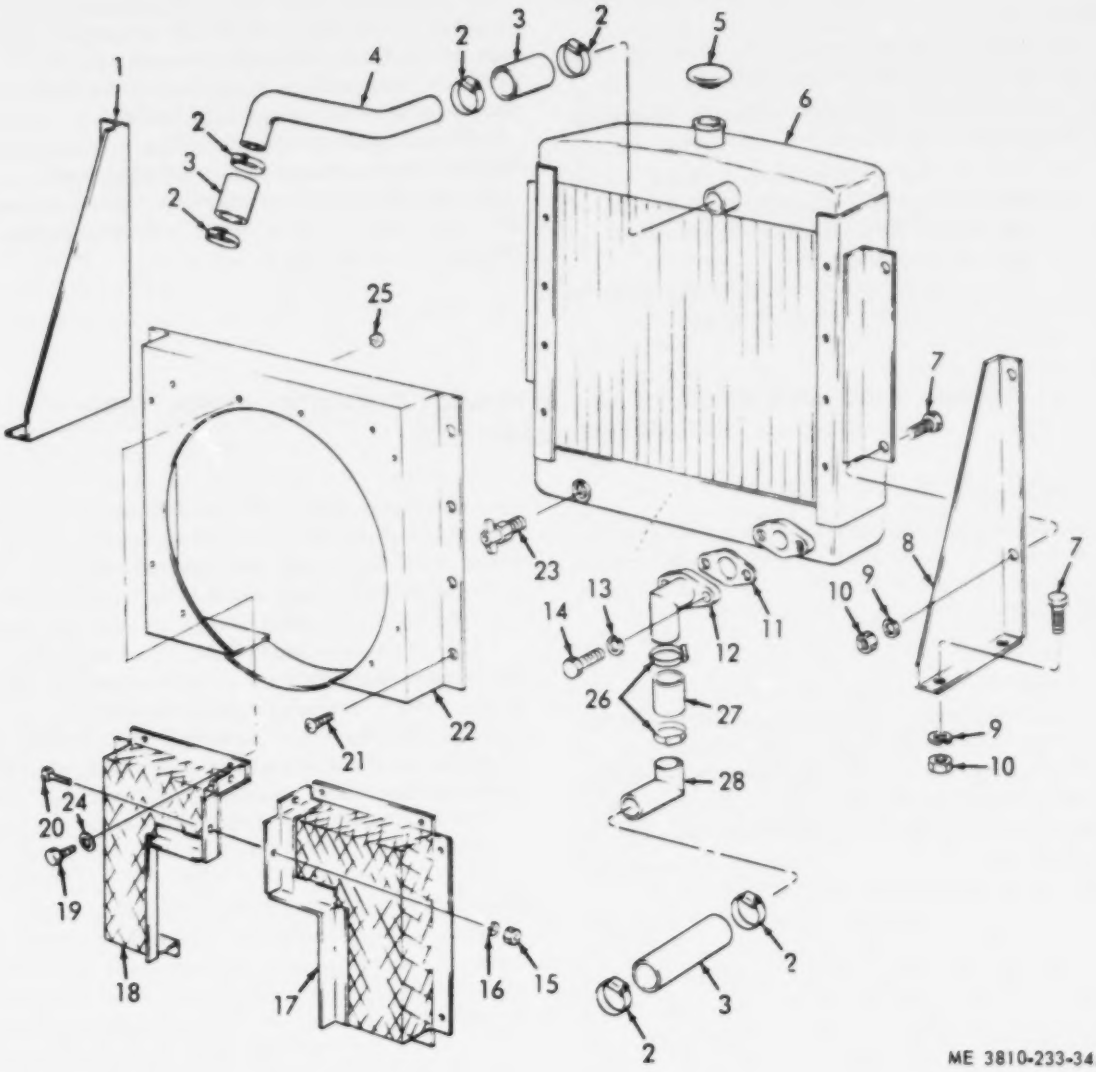
(5) Remove fan guard (TM 5-3810-233-12).

(6) Remove radiator cap.

(7) Remove four nuts, lockwashers, and capscrews which secure the engine front hood panel to the frame. Remove the hood panel.

(8) Remove four nuts (10, fig. 3-33), lockwashers (9), and capscrews (7) which secure the radiator brackets (1 and 8) to the frame.

(9) Lift the radiator assembly from the frame.



1 Bracket
2 Clamp
3 Hose
4 Tube
5 Radiator cap
6 Radiator
7 Capscrew
8 Bracket
9 Lockwasher
10 Nut
11 Gasket
12 Connector
13 Lockwasher
14 Capscrew
15 Nut
16 Lockwasher
17 Fan guard, rh
18 Fan guard, lh
19 Screw
20 Capscrew
21 Screw
22 Shroud
23 Drain cock
24 Washer
25 Nut
26 Clamp
27 Hose
28 Connector

Figure 3-33. Radiator assembly, shroud and fan guard, exploded view.

b. Cleaning, Inspection, and Repair.

(1) Blow dust and dirt from radiator core with low-pressure compressed air.

(2) Clean all surfaces with an approved solvent. Dry thoroughly.

(3) Flush the core with clean water and drain.

NOTE

If hard water has caused scale to form in the core, fill the radiator with a de-scaling solvent and allow to stand for an hour. Drain and fill radiator with a neutralizer; drain and flush with clean water.

(4) Inspect the upper and lower tanks and tube connections for cracks or other damage. Inspect the core for bent fins. Straighten fins or replace core assembly.

(5) Plug the openings and immerse the radiator assembly in water; apply 10 pounds per square inch air pressure and check for leaks. Replace leaky core.

NOTE

It is not necessary to remove shroud and support brackets from the assembly unless the core is replaced.

(6) Remove lower tube connection (12) and replace the cork gasket (11).

(7) Inspect hose clamps (2) for cracks and stripped threads. Replace as required.

c. Installation.

(1) Install new hose (3 and 27) on upper and lower tube connections.

(2) Install radiator in chassis in reverse order of removal.

(3) Tighten hose clamps securely and close drain cock.

(4) Fill radiator with clean, soft water. Operate the engine for a few minutes to observe the temperature gage reading (165-185°F.), and inspect all connections for leaks.

3-54. Fan Assembly

a. Removal. Refer to TM 5-3810-233-12 and remove the fan assembly.

b. Disassembly.

(1) Remove the hub cap (4) from the hub (7).

(2) Remove the retainer ring (5, fig. 3-34), and adjusting bracket (16) from the assembly.

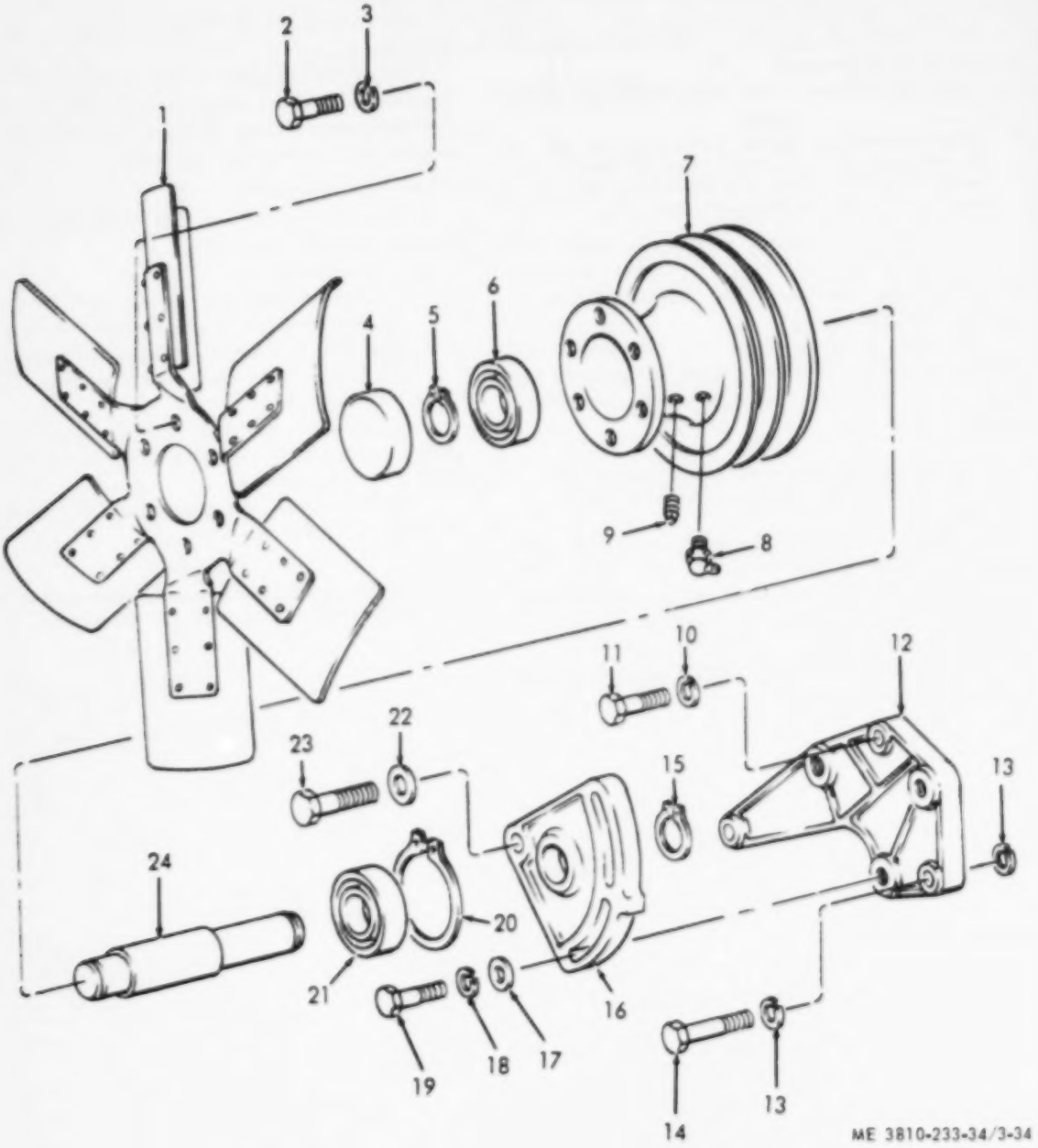
(3) Remove the inner retaining ring (15) and outer retaining ring (20).

(4) Remove the shaft (24) from the hub and pulley assembly by tapping the end of the shaft with a soft hammer.

(5) Press the inner bearing (21) and outer bearing (6) from the hub.

NOTE

Check the number and location of shims used on the outer bearing for shaft end play adjustment.



1 Fan blade
2 Capscrew
3 Lockwasher
4 Cap
5 Retainer ring
6 Bearing
7 Hub
8 Lubrication fitting
9 Pipe plug
10 Lockwasher
11 Capscrew
12 Support
13 Lockwasher
14 Capscrew
15 Retainer ring
16 Adjusting bracket
17 Washer
18 Lockwasher
19 Capscrew
20 Retainer ring
21 Bearing
22 Washer
23 Capscrew
24 Shaft

Figure 3-34. Fan assembly, exploded view.

c. Cleaning, Inspection, and Repair.

(1) Wash all parts with an approved cleaning solvent and dry thoroughly with compressed air.

(2) Hold the bearings by the inner race and rotate. If roughness, binding, or excessive play is detected, replace the bearings.

(3) Inspect the pulley and hub assembly for rough spots or severely worn grooves. Remove any rust or rough spots with fine emery cloth. Replace pulley with damaged or severely worn grooves.

(4) Inspect the fan blades for cracks or bent blades. Replace a fan blade assembly with bent blades.

d. Assembly.

(1) Apply a good grade of all-purpose grease to the rollers of both bearings.

(2) Install the bearings in the hub with the protruding edge of the inner race facing outward from the hub. Fill the hub cavity about one-fourth full of grease before installing outer bearing.

NOTE

Replace the shims (if used) in the same position as removed during disassembly.

(3) Reassemble the fan assembly in the reverse order of disassembly (para *b* above).

NOTE

Fill hub cap about three-fourths full of grease before replacing.

(4) Place the assembly in a horizontal position and check the shaft end play. This should just be discernible (0.002—0.005 inch). Use shims as required to adjust the shaft end play.

e. Installation. Refer to TM 5-3810-233-12 and install the fan assembly.

3-55. Water Pump

a. Removal. Remove the water pump assembly (TM 5-3810-233-12).

b. Disassembly.

(1) Remove four nuts (12, fig. 3-35) and lockwashers (13).

(2) Remove the pump cover (15) and gasket (10).

(3) Place the pump on its mounting flange in an arbor press. Place a short rod slightly less in diameter than the shaft assembly (4) on the end of the shaft, and press the shaft and bearing assembly from the impeller (16), seal assembly (18), and pump body (11).

NOTE

Some models of the water pump incorporate a groove pin to secure the impeller to the shaft. In such models, extra pressure on the arbor press will be required to shear the pin.

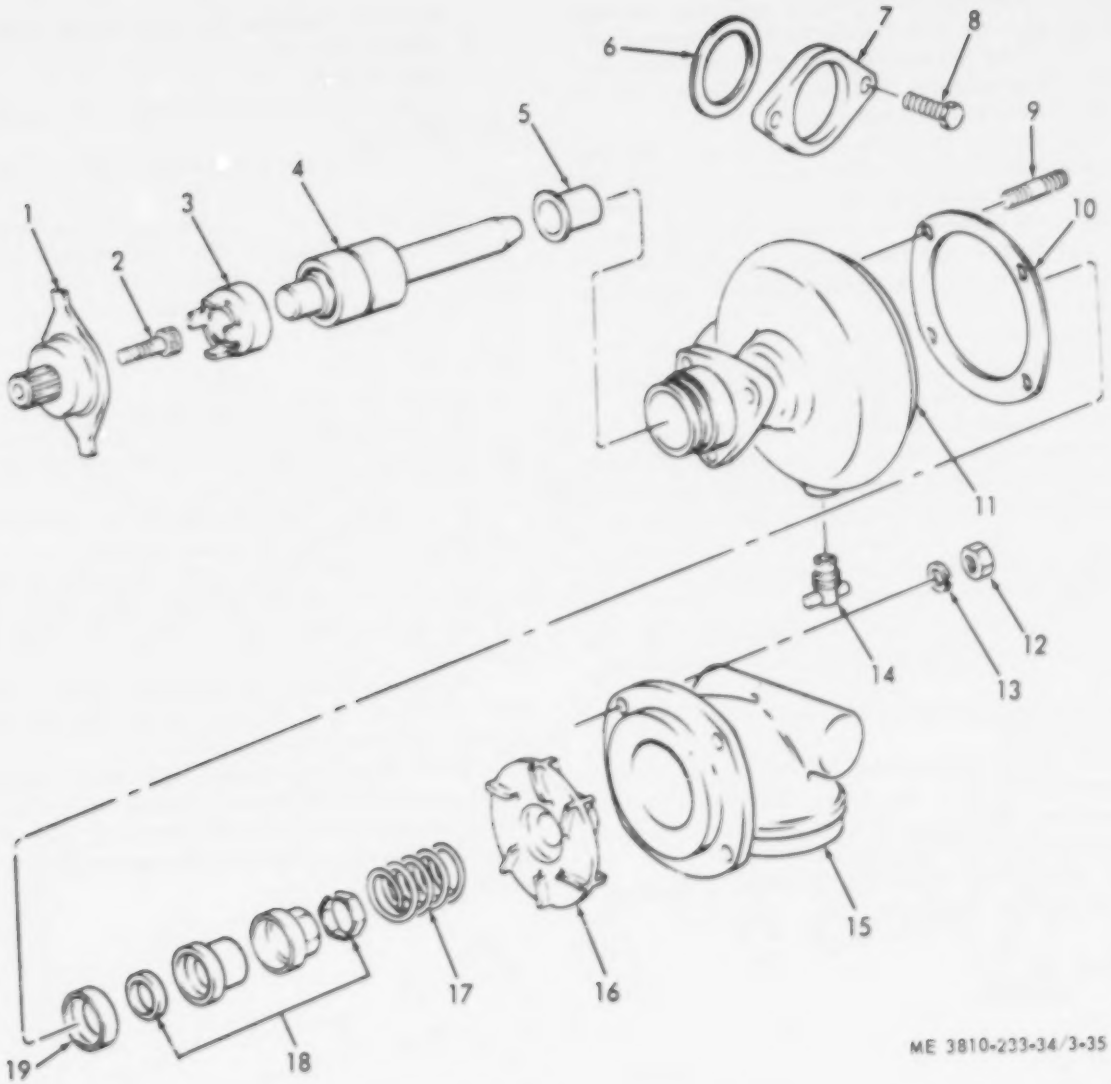
(4) Remove the impeller (16) and seal assembly (18) from the pump body (11).

(5) If the steel insert (19) is scored or worn excessively, press the insert from the pump body.

(6) Remove the water slinger (5) from the shaft (4).

(7) Remove the sheared groove pin, if used, from the shaft and impeller, by driving out with tapered drift and hammer.

(8) If necessary, remove the drive coupling (1) from the shaft by placing a short steel rod in a vise, placing the drive coupling over rod with short length of pipe over shaft and driving coupling from shaft.



1 Intermediate coupling
2 Capscrew
3 Drive coupling
4 Shaft assembly
5 Slinger
6 Packing
7 Flange
8 Capscrew
9 Stud
10 Gasket
11 Body
12 Nut
13 Lockwasher
14 Drain cock
15 Cover
16 Impeller
17 Spring
18 Seal assembly
19 Insert

Figure 3-35. Water pump assembly, exploded view.

e. Cleaning, Inspection, and Repair.

(1) Clean all parts, *except the shaft and bearing assembly*, with an approved cleaning solvent.

(2) Rotate the shaft bearing (4) slowly by hand. If rough spots are detected, replace the shaft and bearing assembly.

(3) Inspect the impeller (16) and seal components (18) for wear. Replace as required.

(4) Inspect the studs in the pump body. When replacing stud(s), use a thread sealant and tighten the studs to 10-12 ft-lb. torque.

(5) If steel insert (19) has been removed, replace with new insert.

CAUTION

Clean counterbore in pump body thoroughly. Start counterbored end of insert into pump body. Then press insert carefully until it contacts the shoulder in the pump body. (The insert has a press fit of 0.0015-0.0035 inches). Do not mar the polished seal contact surface of the insert when pressing into the pump body.

d. Assembly.

(1) Install the water slinger (5) on the pump shaft with the flange end of the slinger 3 / 16-inch from the outer race of the bearing (4).

(2) Place the pump body (impeller end down) in the arbor press. Insert the slinger end of the shaft and bearing assembly into the pump body. Press against the outer race of the bearing until the bearing is seated against the shoulder in the pump body.

(3) Stake the end of the pump body in three places to prevent bearing movement endwise.

(4) Make sure that the seal assembly is perfectly clean. Apply a thin coat of liquid soap (or other noncorrosive lubricant) on the inside diameter of the rubber seal.

CAUTION

Do not mar or scratch the surface of the carbon seal washer.

(5) Slide the seal assembly on the pump shaft until the carbon washer is seated against the pump body insert.

(6) Install the spring (17) with the small end toward the seal.

(7) Install the impeller on the shaft. Aline the hole in the impeller with the hole in the shaft.

(8) Support the bearing end of the shaft on the bed of the arbor press. Press the impeller on the shaft until the face of the impeller hub is 0.052-0.072 inches below the face of the pump body (fig. 3-36).

NOTE

A special tool may be available to obtain the above clearance. Otherwise, check with straight edge across face of pump body and depth gage.

(9) Check hole alinement in impeller hub and shaft. Install groove pin.

(10) Place impeller end of shaft on arbor press bed and install the drive coupling. The drive coupling must be flush with the end of the shaft, and tight on the shaft.

(11) Rotate the shaft by hand to check the clearance between the impeller and pump body.

(12) Place a new gasket (10, fig. 3-35) on the pump body (11). Replace the cover (15) and secure with the four nuts and lockwashers.

NOTE

If the intermediate coupling (1) was removed, insert the splined end of the coupling into the mating splines in the blower rotor shaft. Secure the coupling in place with the capscrew (2) and tighten to 15-19 ft-lb. torque.

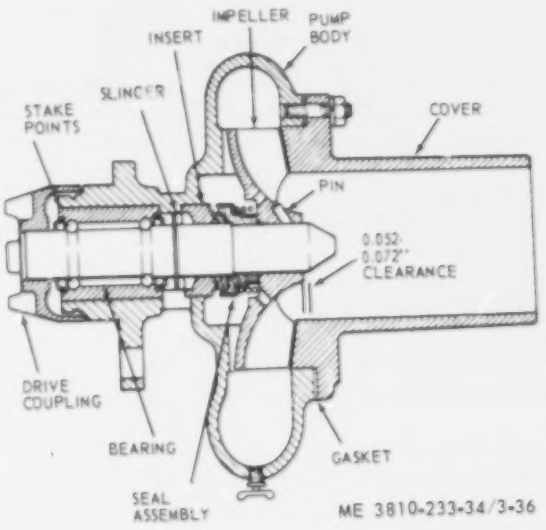


Figure 3-36. Water pump, cross-section view.

e. Installation. Install the water pump assembly on the engine (TM 5-3810-233-12).

Section XIII. CRANKSHAFT PULLEY

3-56. General

The crankshaft pulley is located on and attached to the front end of the engine crankshaft. The pulley drives the fan assembly through a matched set of V-belts, and the engine alternator through a single V-belt. In addition, an adapter is bolted to the pulley, and through a flexible coupling, drives the pump for the crane hydraulic system.

3-57. Crankshaft Pulley

a. Removal.

(1) Remove the radiator (para 3-53).

(2) Remove the fan drive belts and alternator drive belt (TM 5-3810-233-12).

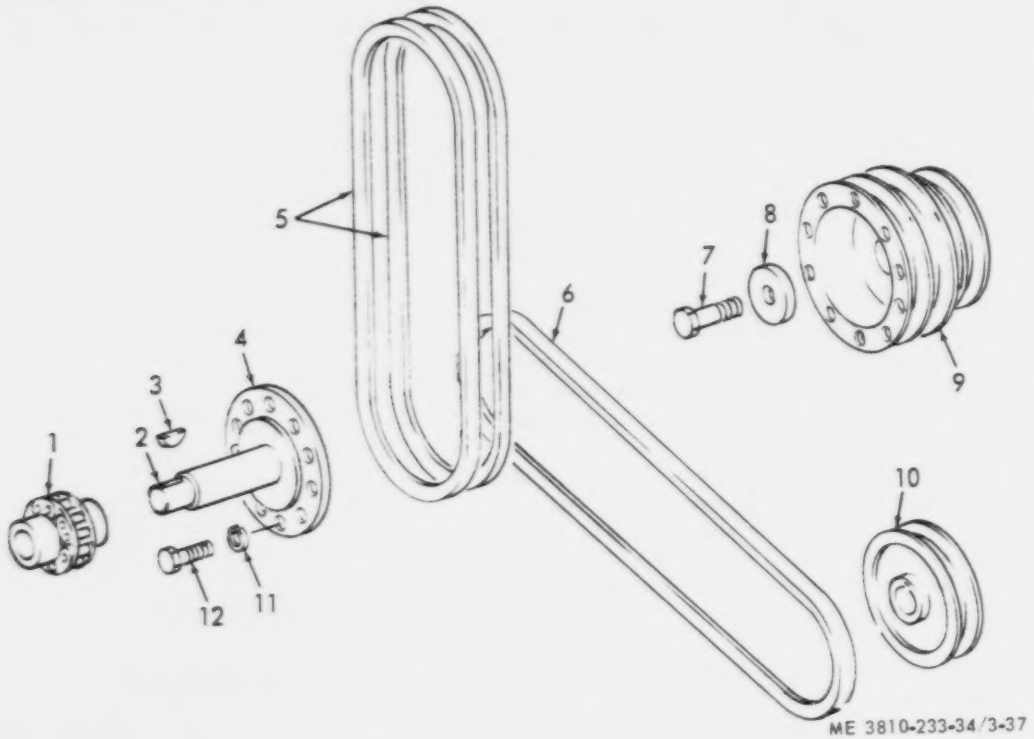
(3) Remove the crane hydraulic pump (TM 5-3810-233-12).

(4) Remove the 10 capscrews (12, fig. 3-37)

and lockwashers (11) that secure the hydraulic pump drive adapter to the crankshaft pulley (9). Remove the adapter and key (3).

(5) Remove the bolt (7) and washer (8).

(6) Remove the crankshaft pulley (9) from the crankshaft with a suitable puller.



1 Coupling
2 Shaft
3 Key
4 Adapter
5 Belt
6 Belt
7 Bolt
8 Washer
9 Pulley
10 Pulley
11 Lockwasher
12 Capscrew

Figure 3-37. Crankshaft pulley, V-belts, adapter and details.

b. Cleaning, Inspection, and Repair.

(1) Clean the pulley, adapter, and hardware with an approved cleaning solvent. Dry thoroughly.

(2) Inspect the pulley for cracks or damaged grooves. If excessive wear is indicated in the bottom of the grooves, replace the pulley. Inspect the adapter for damage.

c. Installation.

(1) Make sure that the two keys are securely seated in the crankshaft. Lubricate the end of the crankshaft; aline the keyway in the pulley with the keys and slide the pulley on the crankshaft.

(2) Install the washer (8) on the bolt (7) and screw into the threaded end of the crankshaft. Tighten the retaining bolt to 290-310 ft-lb. torque.

(3) Install the adapter (4) on the pulley hub and secure with the capscrews (12) and lockwashers (11). Tighten the capscrews alternately until the adapter is securely fastened to the pulley.

(4) Install the remaining components in the reverse order of removal.

Section XIV. FLYWHEEL ASSEMBLY AND FLYWHEEL HOUSING

3-58. General

A combination flywheel housing and gear train cover is attached to the rear cylinder block end plate and houses the flywheel and gear train. The flywheel assembly is bolted securely to a flange on the crankshaft and is dowelled in two places. One of the bolt holes is offset and the flywheel can be mounted in only one position. The bolt heads are

drilled and secured with lockwire. When self-locking bolts are used, a retainer (scuff) plate is added to prevent the bolts from scoring the face of the flywheel. A starter ring gear of heat-treated steel is shrunk onto the rim of the flywheel.

3-59. Flywheel Assembly

a. Removal and Disassembly.

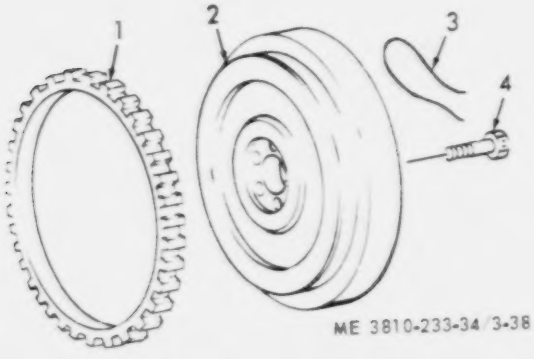
(1) Remove the engine (para 2-7).

(2) Support the engine on an overhaul stand or other suitable foundation and remove the three lockwires (3, fig. 3-38) from the head of the bolts (4).

(3) Remove the six bolts and lift the flywheel assembly off the crankshaft and out of the flywheel housing with a suitable tool and lifting device.

(4) Place the flywheel assembly, crankshaft side down, on a solid flat surface or block slightly less in diameter than the flywheel.

(5) Drive the ring gear (1) off the flywheel (2) with a suitable drift and hammer. Keep working around the circumference of the ring gear to avoid binding the gear on the flywheel.



1 Gear
2 Flywheel
3 Wire
4 Bolt

Figure 3-38. Flywheel assembly, exploded view.

b. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent and dry thoroughly.

(2) Inspect the flywheel for cracks, breaks, warpage, and elongated holes. Replace a flywheel showing any signs of damage or excessive wear.

(3) Inspect the ring gear for broken or chipped teeth. If the gear is defective, replace it.

(4) Inspect the hardware for cracks, breaks, or damaged threads. Replace as required.

c. Assembly.

(1) Support the flywheel in a level position with the side which goes toward the cylinder block facing up.

(2) Place the ring gear on a metal surface and heat the gear uniformly with a blow torch or acetylene torch. Keep the torch moving around the circumference of the gear to avoid hot spots.

CAUTION

Do not heat the ring gear in excess of 400°F. Excessive heating may destroy the original heat treatment.

(3) Place the heated ring gear in position on the flywheel with the ring gear chamfer, if any, facing in the same direction as the gear just removed.

(4) Tap the ring gear (1) down in place against the shoulder on the flywheel (2). Use a lead or other soft metal hammer, tapping the gear lightly at a number of points around its circumference.

d. Installation.

(1) Install the flywheel assembly in the flywheel housing over the pins in the crankshaft and insert the six bolts (4). Tighten the bolts alternately to 150-160 ft-lb. torque. Secure with the lockwires (3).

(2) Install the engine in the crane (para 2-7).

3-60. Flywheel Housing

a. Removal.

(1) Remove the flywheel assembly (para 3-59).

(2) Remove the two screws and lockwashers that secure the engine rear lifter bracket to the cylinder head.

(3) Remove the six screws and flatwashers that secure the flywheel housing (2) to the idler gear hub and idler gear hole spacer.

(4) Remove the six screws (18, fig. 3-39) and lockwashers (7) that secure the flywheel housing to the cylinder block.

(5) Remove the screws (3 and 9) and lockwashers (10) that secure the upper portion of the flywheel housing to he engine rear end plate.

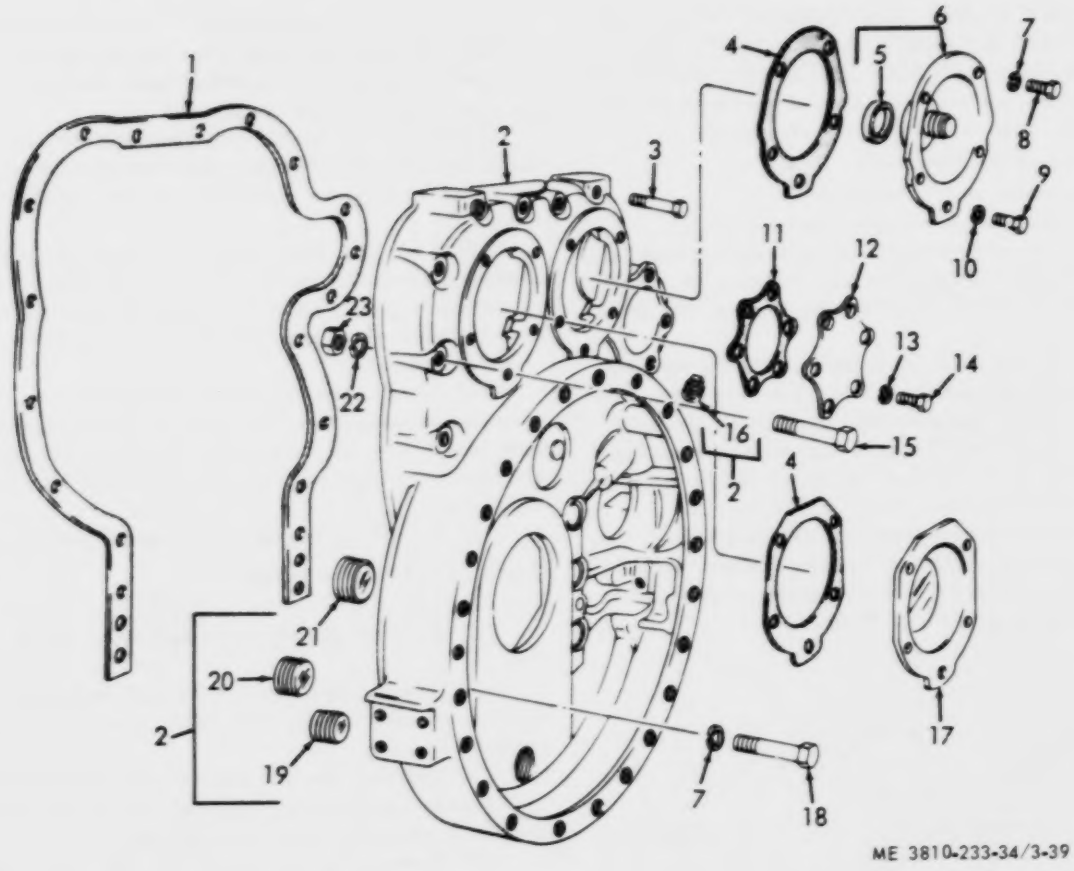
(6) Remove the two screws and lockwashers which go through the rear end plate from the front and thread into the flywheel housing (2).

(7) Remove the remaining screws (15), lockwashers (22), and nuts (23) that secure the flywheel housing to the rear end plate.

(8) With the flywheel housing supported by a chain hoist attached to the lifter bracket, strike the front face of the housing alternately on each side of the engine with a soft hammer to work it off the dowels in the cylinder block and away from the cylinder block rear end plate. Lift the flywheel housing (2) away from the engine and remove the gasket (1).

(9) Remove the plugs (19, 20, and 21) from the flywheel housing (2).

(10) Remove the screws (8, 9, and 14) and lockwashers (7, 10, and 13) and remove the flywheel housing covers (6, 12, and 17), flywheel housing cover gaskets (4) from the flywheel housing.



1 Gasket
2 Housing assembly
3 Screw
4 Gasket
5 Seal
6 Cover assembly
7 Washer
8 Screw
9 Screw
10 Washer
11 Gasket
12 Cover
13 Washer
14 Screw
15 Screw
16 Plug
17 Cover
18 Screw
19 Plug
20 Plug
21 Plug
22 Washer
23 Nut

Figure 3-39. Flywheel housing assembly, exploded view.

b. Cleaning, Inspection, and Repair.

(1) Clean all metal parts of the flywheel housing with an approved cleaning solvent and dry thoroughly.

CAUTION

It is very important that all old gasket material be completely removed from the flywheel housing and engine end plate, otherwise alinement may be affected when the housing is installed on the engine.

(2) Inspect the flywheel housing and covers for cracks, breaks, warpage, and elongated holes. Replace a damaged or excessively worn flywheel housing or cover.

(3) Inspect the crankshaft rear oil seal for scoring or damage. Replace a defective oil seal.

(4) Inspect all hardware for cracks, breaks, or damaged threads. Replace as required.

c. Assembly.

(1) Install the pipe plugs (19, 20, and 21) in the flywheel housing (2).

(2) Affix new gaskets (4) to the flywheel housing covers (6 and 17). Secure the covers to the flywheel housing with the screws and lockwashers.

(3) Lubricate the oil seal lip and install the oil seal, if removed, into the flywheel housing (2) with a suitable tool.

(4) Affix a new gasket (1) to the bolting flange of the flywheel housing (2).

d. Installation.

(1) With the flywheel housing supported by a chain hoist attached to the lifter bracket, lift the flywheel housing into position at the crankshaft. Install the flywheel housing (2) on the crankshaft, using an oil seal expander tool to seat the flywheel housing tight against the gasket and end plate.

(2) Start the screws in the idler gear hub, idler gear hub spacer, and rear end plate.

(3) Start the screws, lockwashers, and nuts around the upper portion of the flywheel housing. Install the two screws and lockwashers which go through the rear end plate and thread into the flywheel housing. Tighten all screws and bolts finger tight.

(4) Loosen the engine lifter bracket-to-flywheel housing bolts.

(5) Refer to figure 3-40 for initial bolt tightening sequence, and final bolt tightening sequence.

(6) Rotate the crankshaft by hand when tightening the idler gear hub bolts to prevent binding and/or damage to the tapered roller bearing.

NOTE

Tighten the idler gear hub and hole spacer bolts (six ⅜"-16) to 40-45 ft-lb. torque. Tighten all other ⅜-inch bolts to 25 to 30 ft-lb. torque. Tighten all ½-inch bolts to 90-100 ft-lb. torque.

(7) Measure the flywheel housing concentricity in relation to the crankshaft. Runout of the pilot (inner edge) of the flywheel housing should not exceed 0.013 inch total indicator reading when indicated from the crankshaft. Runout of the flywheel housing face should also be measured. The maximum allowable limit 0.013 inch.

(8) Remove the bolts holding the engine lifter bracket to the flywheel housing. Affix a new gasket to the bracket and alternately tighten the bracket-to-flywheel housing and bracket-to-cylinder head bolts to 55 to 60 ft-lb. torque.

(9) Install the flywheel assembly (para 3-59).

(10) Install the engine in the crane (para 2-7).

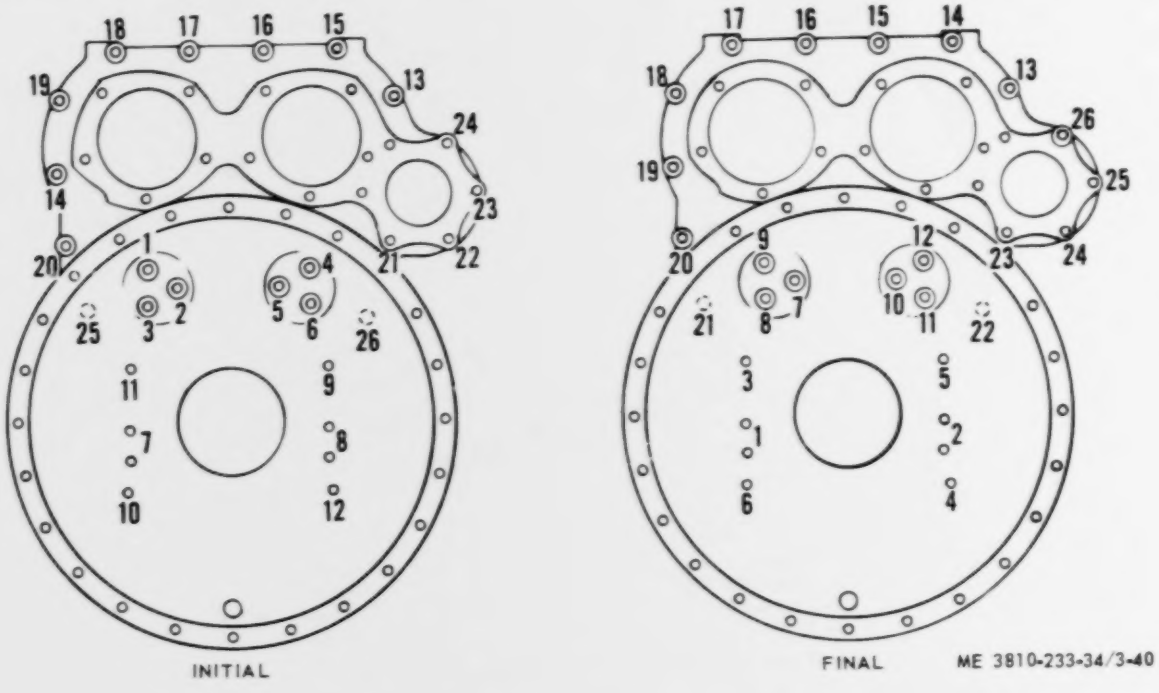


Figure 3-40. Flywheel housing bolt tightening sequence.

Section XV. CAMSHAFT, BALANCE SHAFT AND BALANCE WEIGHT COVER

3-61. General

The camshaft which operates the injectors and exhaust valves is a one-piece drop forging with case-hardened cams and journals. It is located near the top of the cylinder block on the blower side. The balance shaft runs parallel to the camshaft on the opposite side of the cylinder block. The function of the balance shaft is to counterbalance the rotation of the weighted camshaft. The balance weight cover is attached to the cylinder block and front end plate and houses the camshaft and balance shaft weights.

3-62. Balance Weight Cover

a. General. The balance weight cover incloses the front engine balance weights and serves as a support for the fan assembly. The cover does not require servicing but must be removed whenever the camshaft, balance shaft, or balance weights require replacing.

b. Removal.

(1) Remove the engine (para 2-7).

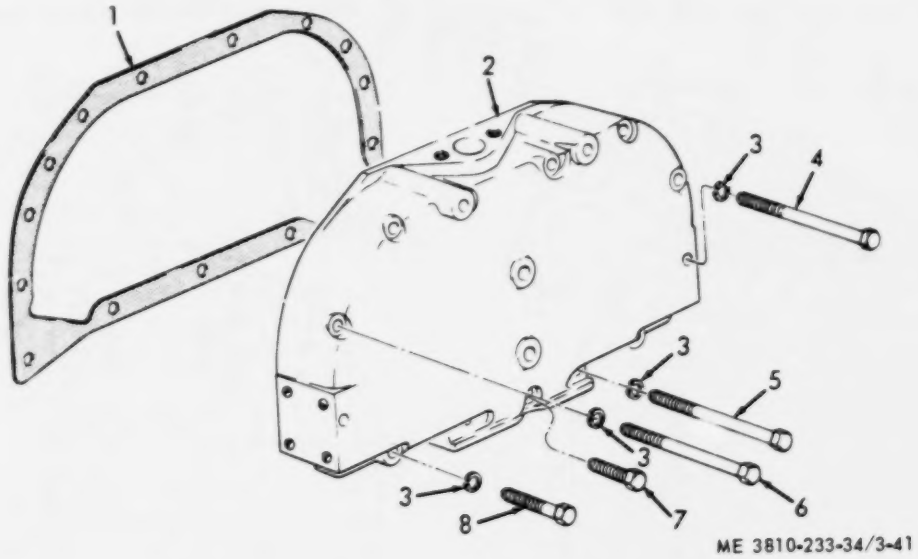
NOTE

Removal of the engine is not required to replace the balance weights, but the radiator (para 3-53) and fan assembly (para 3-54) must be removed before the balance weight cover can be removed.

(2) Remove the two screws and lockwashers that attach the front engine lifter bracket to the cylinder head.

(3) Remove the 15 screws (4, 5, 6, 7, and 8, fig. 3-41) and lockwashers (3) that attach the cover to the cylinder block and front end plate.

(4) Remove the cover (2) and gasket (1). Discard the gasket.



1 Gasket
2 Cover assembly
3 Lockwasher
4 Screw
5 Screw
6 Screw
7 Screw
8 Screw

Figure 3-41. Balance weight cover, exploded view.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Clean all traces of the old gasket from the cover.

(3) Inspect the balance weight cover for breaks, cracks, or elongated bolt holes. Replace a defective cover.

(4) Inspect all hardware for damaged threads or signs of fatigue. Replace as required.

d. Assembly. Affix a new gasket (1) on the cover (2).

e. Installation.

(1) Set the cover in place and secure with the attaching hardware. Finger tighten the screws.

(2) Start at eleven o'clock and proceed in a clockwise direction; tighten all screws to 25-30 ft-lb. torque.

(3) Install the engine lifter bracket screws in the cylinder head.

3-63. Camshaft and Balance Shaft

a. Removal.

(1) Remove the engine (para 2-7).

(2) Remove the cylinder head assembly (para 3-23).

(3) Remove the flywheel housing (para 3-60).

(4) Remove the balance weight cover (para 3-62).

(5) Place a wood block between the balance weights (13, fig. 3-42).

(6) Remove the capscrews (1), lockwashers (2), and the gear nut retainers (4).

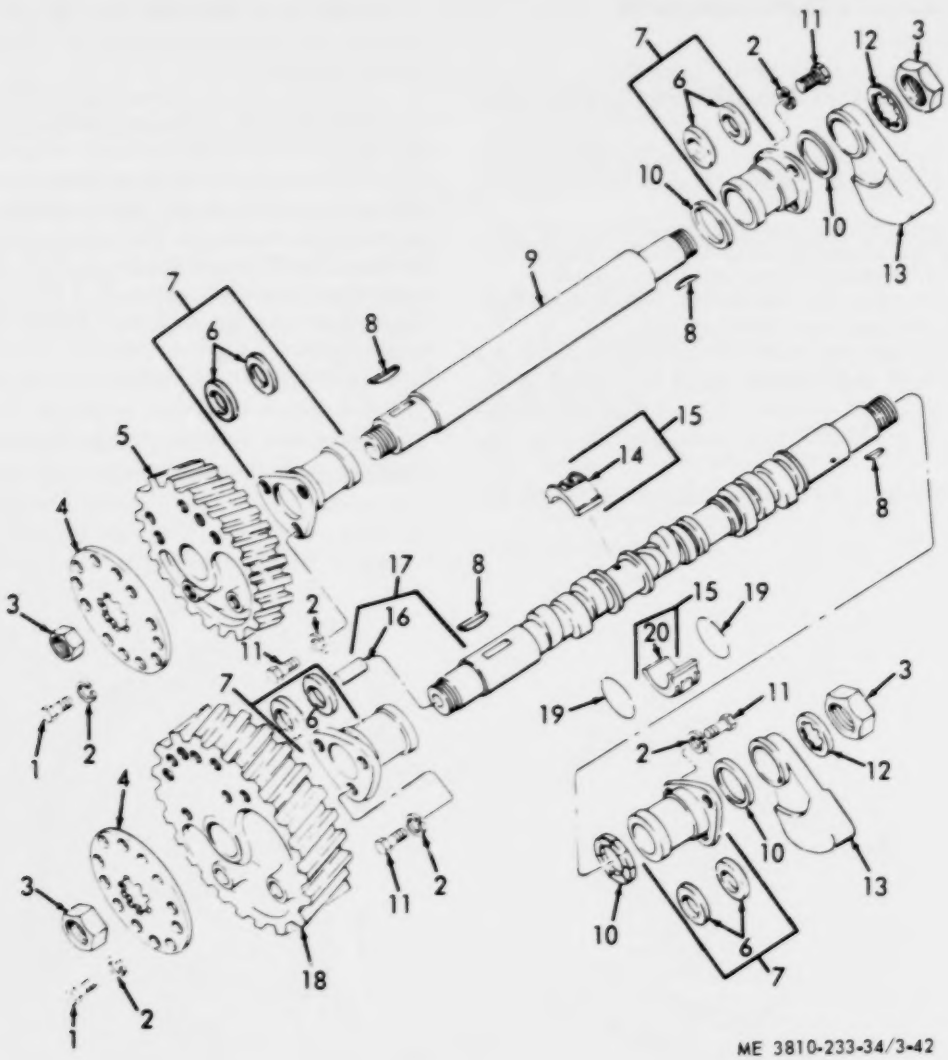
(7) Loosen the nuts (3) at each end of the camshaft (17) and balance shaft (9). Remove the nuts (3) and lockwashers (12) at balance weight end. Do not remove nuts from gear end of the shafts.

(8) Remove the balance weights (13) from the shafts by inserting two pry bars between the weights and the front bearings (7). Remove the two thrust washers (10).

(9) Remove the lockscrew from the top of the cylinder block at each camshaft intermediate sleeve bearings.

(10) Remove the three screws (11) and lockwashers (2) that secure the camshaft and balance shaft sleeve bearings (7) to the rear end plate. Remove the balance shaft gear (5) and camshaft gear (18) from the rear end of the cylinder block and rear end plate with shafts and bearings assembled.

(11) Remove the screws (11) and lockwashers (2) that secure the sleeve bearings (7) to the front end plate and cylinder block. Remove the sleeve bearings and thrust washers.



1 Capscrew
2 Lockwasher
3 Nut
4 Gear nut retainer
5 Balance shaft gear
6 Thrust washer
7 Bearing
8 Key
9 Balance shaft
10 Thrust washer
11 Capscrew
12 Lockwasher
13 Balance weight
14 Bearing (upper half)
15 Bearing set
16 Plug
17 Camshaft (includes plug 16)
18 Camshaft gear
19 Bearing lock ring
20 Bearing (lower half)

Figure 3-42. Camshaft and balance shaft assemblies, exploded view.

b. Disassembly.

(1) Support the camshaft in the soft jaws of a bench vise being careful not to damage the cams.

(2) Remove the camshaft gear (18) from the camshaft (17) with a suitable puller.

(3) Remove the sleeve bearing (7), thrust washers (6), and woodruff key (8) from the camshaft.

(4) Remove the two camshaft oil hole plugs (16) from the camshaft.

(5) Remove the two lock rings (19) that secure the intermediate bearings (15) to the camshaft and remove the bearings.

(6) Remove the balance shaft gear (5) from the balance shaft (9) with a suitable puller.

c. Cleaning and Inspection.

(1) Clean all parts with an approved cleaning solvent and air dry. Be sure all oil passages are clean.

(2) Inspect the bearings, cams, and shaft journals for cracks, breaks, scoring, and wear limits as described in table 1-4. If shaft or bearings are worn or damaged, replace them.

(3) Inspect all thrust washers and, if either face is scored, replace them. Inspect the surfaces which the thrust washers contact; if these surfaces are scratched, but not severely scored, they may be smoothered up with an oil stone. However, if the score marks are too deep to be removed or parts are badly worn, replace them.

(4) Inspect all applicable parts for damaged threads. Replace damaged threaded parts.

d. Assembly.

(1) Install new end plugs (16) in the camshaft.

(2) Lubricate the camshaft and balance shaft journals and slide the rear bearings (7) on each shaft with the bearing mounting flange facing the gear end of each shaft.

(3) Install the keys (8) in both shafts.

(4) Place the non-gear end of the camshaft on a block of wood. Aline the camshaft gear keyway with the key and drive the gear on the camshaft with a hollow installing tool until the gear is seated against the shaft shoulder.

CAUTION

Do not interchange the two gears. The teeth on the camshaft form a left-hand helix, and conversely, the teeth of the balance shaft form a right-hand helix.

(5) Install the balance shaft gear in a similar manner.

(6) Start the nuts (3) on the shafts but do not tighten.

(7) Lubricate the intermediate camshaft journals. Place the two halves (14 and 20) of each intermediate bearing on the journals and secure each set in place with two lock rings (19). The gap in each lock ring should be centered on the upper bearing half (14).

e. Installation.

(1) Start the assembled balance shaft gear into position from the rear end of the cylinder block opposite the blower side. Continue pushing the balance shaft into position until the gear teeth are about to engage with the idler gear.

(2) Correctly position the crankshaft, idler, and balance shaft gear so the R timing marks are adjacent as shown in figure 3-43.

(3) Secure the balance shaft sleeve bearing (7, fig. 3-42) to the rear end plate with the three screws (11) and lockwashers (2).

(4) Start the camshaft into the bore in the cylinder block. When the teeth of the camshaft are about to engage the balance shaft gear, revolve the gears, if necessary, so the O marks on the gears will match as shown in figure 3-43.

(5) Secure the camshaft sleeve bearing (7, fig. 3-42) to the rear end plate with screws (11) and lockwashers (2).

(6) Apply an approved grease to the steel faces of the thrust washers (10). Position them against the inner end of the sleeve bearings (7).

NOTE

Be sure the steel faces of the camshaft and balance shaft thrust washers are next to the sleeve bearings.

(7) Install the sleeve bearings into the cylinder block front end plate and secure with the lockwashers (2) and screws (11).

(8) Apply an approved grease to the steel faces of the camshaft and balance shaft thrust washers. Position them against the outer surfaces of the sleeve bearings (7).

(9) Revolve the camshaft intermediate sleeve bearings so the locking holes in the bearing aline with the holes in the top of the cylinder block. Secure the bearings in place with the lockscrews.

(10) Install the keys (8) in the keyways at the front end of the camshaft and balance shaft.

(11) Install the balance weights (13) and lockwashers (12) on the respective shafts and start the nuts (3). Wedge a block of wood between the weights and tighten the nuts to 300 to 325 ft-lb. torque.

(12) Edge a clean cloth between the balance shaft gear (5) and camshaft gear (18). Tighten the nuts (3) to 300 to 325 ft-lb. torque.

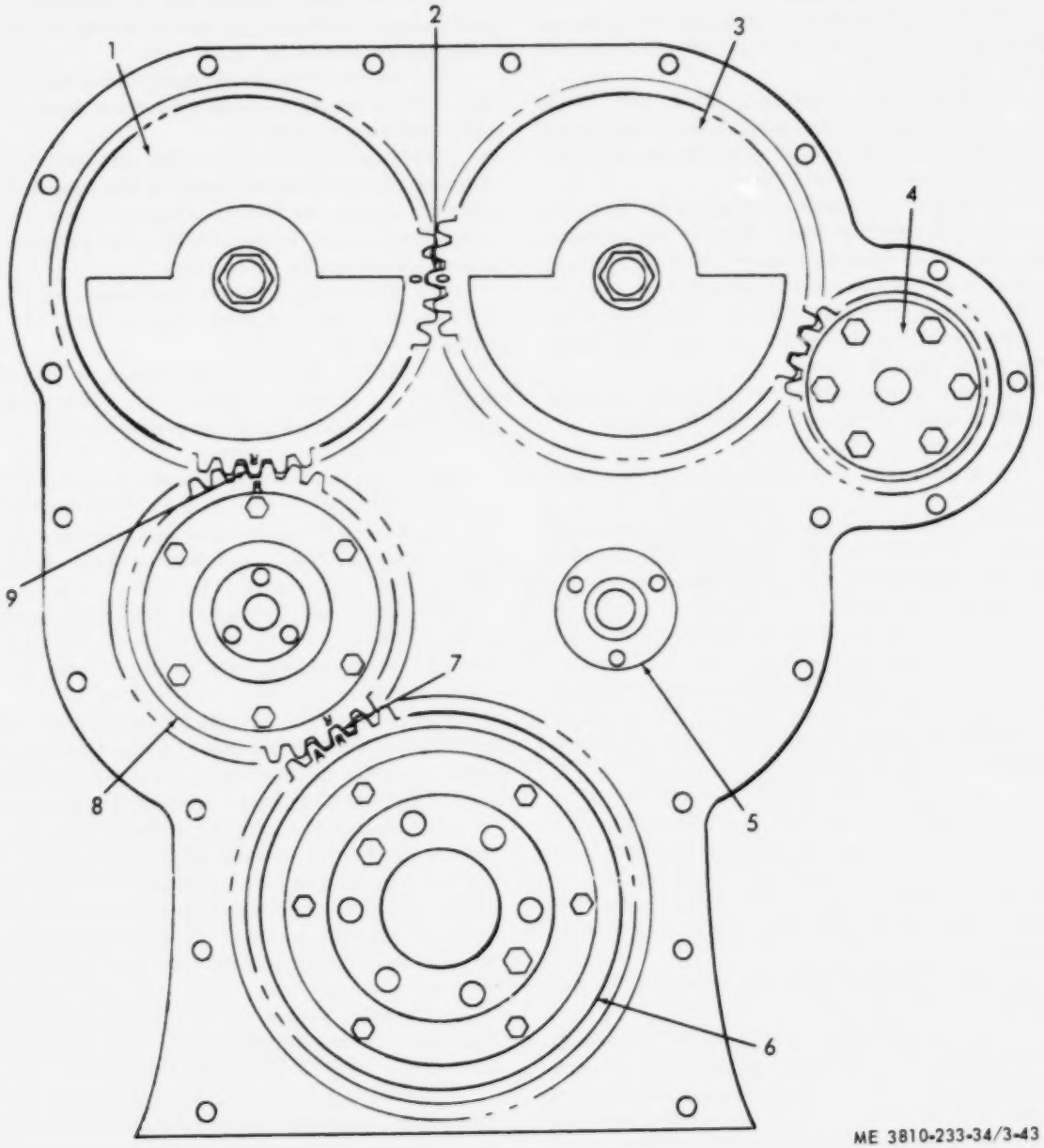
(13) Install the gear nut retainer (4) on the nuts of the camshaft gear and balance shaft gear and secure with the screws (1) and lockwashers (2).

(14) Install the balance weight cover (para 3-62).

(15) Install the flywheel housing (para 3-60).

(16) Install the cylinder head assembly (para 3-23).

(17) Install the engine (para 2-7).



ME 3810-233-34/3-43

1 Balance shaft gear
2 Match marks
3 Camshaft gear
4 Blower drive gear
5 Idler gear hole spacer
6 Crankshaft gear
7 Match marks
8 Idler gear
9 Match marks

Figure 3-43. Gear train and timing match marks.

Section XVI. GEAR TRAIN AND ENGINE TIMING

3-64. General

a. A completely enclosed train of five helical gears is located at the rear end of the engine, as shown in figure 3-43. A gear bolted to the crankshaft drives the camshaft and balance shaft gears, as well as the blower drive gear, through an idler gear mounted between the crankshaft and balance shaft gears.

b. The camshaft gear and balance shaft gear mesh with each other and run at the same speed as the crankshaft. Since these two gears must be in time with each other, and the two as a unit in time with the crankshaft gear, the letter "O" is placed on one tooth of one of the gears with a corresponding mark at the root of the mating teeth of the other gear (fig. 3-43).

c. The camshaft and balance shaft gears are keyed to their respective shafts and held securely against the shoulder on the shaft by a nut. Viewing the engine from the flywheel end, the right-hand gear has left-hand helical teeth (fig. 3-43).

d. The idler gear rotates on a double-row, tapered roller bearing mounted on a stationary hollow hub. This hub is accurately located on the cylinder block end plate, at the left-hand side of the engine, as viewed from the gear train end. A blower drive gear is located on the blower side to transmit power to the blower, governor, fuel pump and water pump. The cam and balance shafts must be in time with the crankshaft and identification marks are located on two teeth of the idler gear with corresponding match marks stamped on the crankshaft gear and the camshaft or balance shaft gear (fig. 3-43).

3-65. Idler Gear Assembly

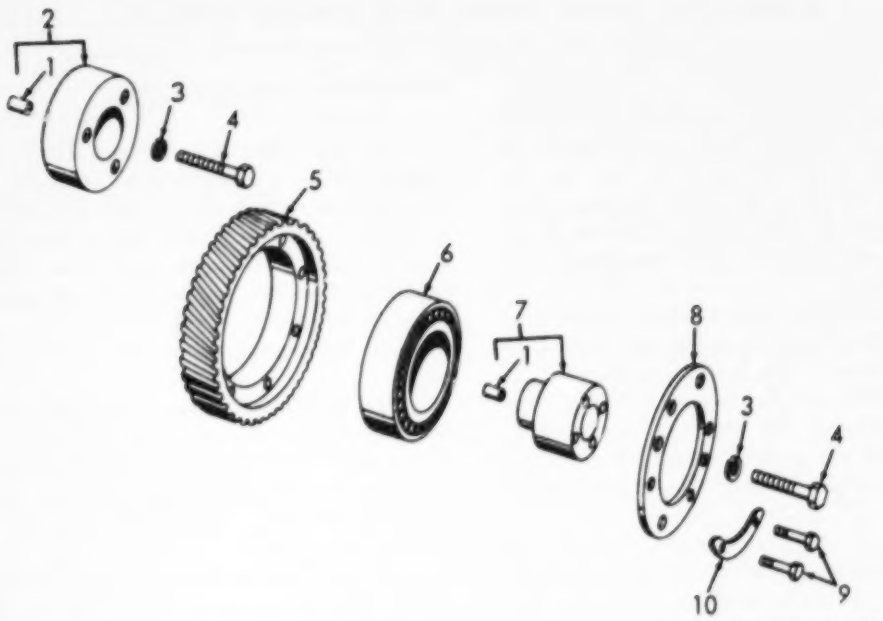
a. General.

(1) The idler gear mounts on a double row, tapered roller bearing which, in turn is supported on a stationary hub (fig. 3-44). A hollow pin serves a twofold purpose; first, as a locating dowel it prevents the idler gear hub from rotating and, second, the hollow pin conducts oil under pressure from an oil gallery in the cylinder block through a passage in the gear hub to the roller bearing inner races.

(2) The inner races of the idler gear bearing are pressed onto the gear hub, and therefore, do not rotate since the hub is doweled to the end plate and bolted to the cylinder block, and also bolted to the flywheel housing. A spacer separates the two bearing inner races.

(3) The bearing outer race has a light press fit in the idler gear and is held against a flanged lip inside the idler gear on one side, and by a retainer secured tightly with six bolts on the other side.

(4) An idler gear hole spacer (dummy hub) (fig. 3-43) is used on the side opposite the idler gear. Gaskets are not used between the idler gear hub, or the dummy hub and the flywheel housing. The flywheel housing bears against the inner race of the idler gear bearing and also against the dummy hub. Three self-locking bolts and steel washers are used to attach the flywheel housing at the idler gear and dummy hub locations.



ME 3810-233-34/3-44

1 Pin
2 Spacer
3 Washer
4 Screw
5 Gear
6 Bearing
7 Hub assembly
8 Retainer
9 Screw
10 Lockplate

Figure 3-44. Idler gear assembly, exploded view.

b. Removal.

(1) Remove the flywheel housing (para 3-60).

NOTE

Before removing the idler gear assembly, grasp the rim of the gear with both hands and rocking the gear in relation to the bearing. Any wobbling or shaking of the gear indicates the need for a new bearing.

(2) Remove the hub-to-cylinder block screw (4, fig. 3-44) and washer (3). Remove the idler gear assembly from the cylinder block rear end plate.

(3) Remove the screw (4), washer (3), and spacer (2).

c. Disassembly.

(1) Remove the six screws (9) and three bolt locks (10) that attach the bearing retainer (8) to the idler gear (5).

NOTE

Component parts of the idler gear bearing are matched. Mark the parts in order that they may be correctly installed when replacing. Always replace a doubtful bearing assembly with a new one.

(2) Place the idler gear and bearing assembly in an arbor press with the bearing cone (inner race) supported by steel blocks. Press the hub (7) out of the bearing (6) while rotating the gear assembly.

(3) Tap the bearing cup from the gear with a brass drift and hammer.

d. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry with compressed air.

(2) Inspect all parts for wear or damage. Inspect the bearings carefully. Wear, pitting, scoring, or flat spots on the roller require replacement of the bearings.

(3) Inspect the gear teeth for scoring, pitting, or appreciable wear. Replace the gear if questionable.

e. Assembly.

(1) Place the idler gear, shoulder down, in an arbor press and press the bearing cup into the gear until securely seated against the shoulder of the gear bore.

(2) Place one bearing cone, numbered side down, on bed of arbor press. Place idler gear and bearing cup assembly over bearing cone.

(3) Insert the spacer ring on face of bearing cone. Place the second bearing cone, numbered side up, in the assembly and against the spacer ring.

(4) Position the idler gear hub over the bearing cones so that the oil hole in the hub is opposite (180°) the gap in the spacer ring.

CAUTION

Support the bearing cones during this operation.

(5) Press the hub into the bearing cones. Rotate the gear during the operation to properly seat the rollers between the cones. Press until the face of the hub, which will be adjacent to the cylinder block end plate, is flush with the corresponding face of the bearing cone.

(6) Install the bearing retainer (8) on the idler gear (5) with the six screws (9) and bolt locks (10). Tighten the screws to 24-29 ft-lb. torque. Bend the ears of the bolt locks against the flat sides of the heads of the attaching screws.

f. Installation.

(1) Position the crankshaft gear and balance shaft gear so that the match marks will aline with those on the idler gear (fig. 3-43).

(2) Start the idler gear into mesh with the above gears, and simultaneously rotate the gear hub (7, fig. 3-44), until the hollow pin (1) in the inner race of the hub is nearly registered with the oil hole in the rear end plate.

(3) Aline the hollow pin with the oil hole and gently tap the hub into place. After making sure that the hub is tight against the end, insert the washer (3) and screw (4). Tighten the screw to 80-90 ft-lb. torque.

(4) Install the spacer (2), or referred to as a dummy hub. Secure with washer (3) and screw (4). Tighten the screw to 80-90 ft-lb. torque.

(5) Lubricate the idler gear and bearing with clean engine oil.

(6) Check the backlash between mating gears. It should be between 0.0030-0.0080 inch with new gears, and must not exceed 0.010 inch with used gears.

(7) Install the flywheel housing (para 3-60).

3-66. Crankshaft Timing Gear

a. General.

(1) The crankshaft timing gear is bolted to the flange at the rear end of the crankshaft and drives the balance shaft gear through an idler gear. One gear attaching bolt hole is offset so that the gear can be attached in only one position.

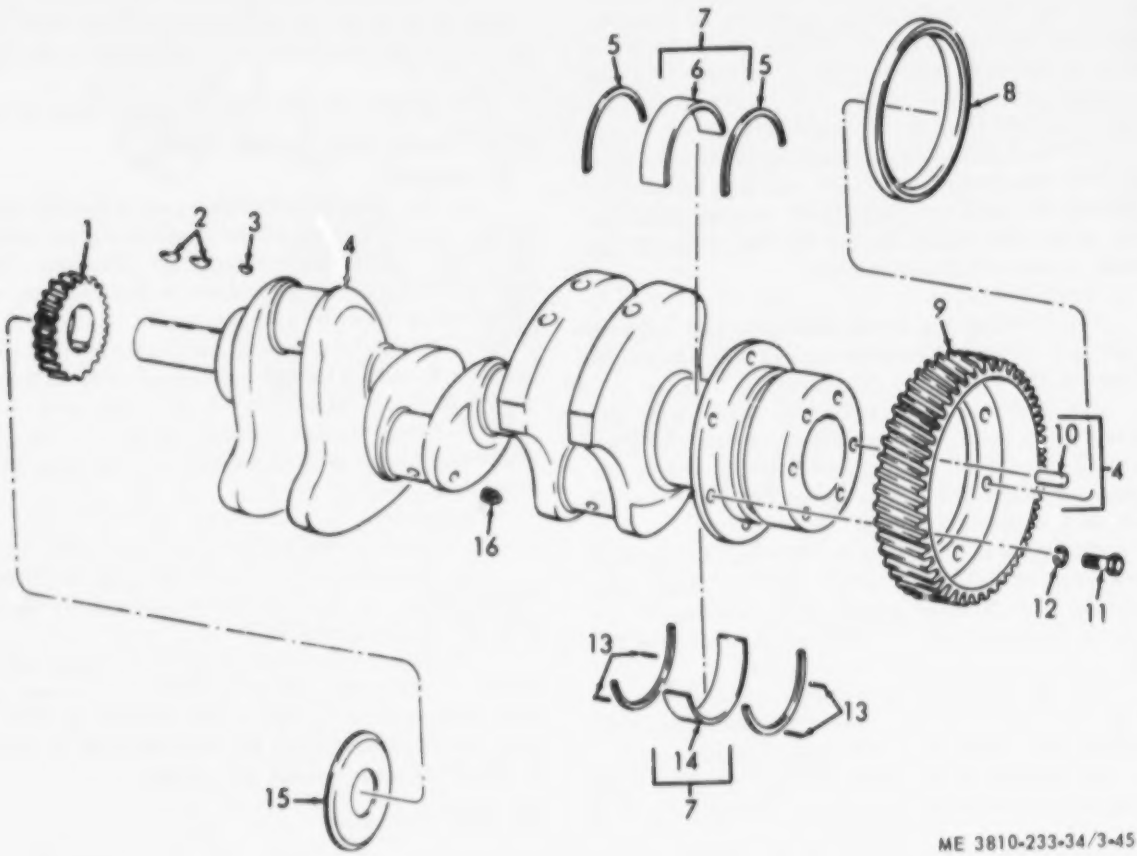
(2) Since the camshaft and balance shaft gear must be in time with the crankshaft, timing marks are located on two teeth of the idler gear with corresponding match marks stamped on the crankshaft gear and camshaft and balance shaft gears (fig. 3-43).

b. Removal.

(1) Remove the flywheel housing (para 3-60).

(2) Remove the six screws (11, fig. 3-45) and lockwashers (12) that attach the crankshaft timing gear (9) to the crankshaft (4).

(3) Remove the crankshaft timing gear with a suitable gear puller. Place a steel plate across the large hole in the end of the crankshaft to provide a base for the puller screw. Remove the gear carefully to avoid damage to the gear teeth.



1 Gear
2 Key
3 Key
4 Crankshaft
5 Washer
6 Bearing half
7 Bearing
8 Seal
9 Gear
10 Pin
11 Screw
12 Washer
13 Pin
14 Bearing half
15 Deflector
16 Plug

Figure 3-45. Crankshaft, bearings, and gears, exploded view.

c. Cleaning, Inspection, and Repair.

(1) Clean the gear with an approved cleaning solvent. Dry with compressed air.

(2) Inspect the gear teeth for scoring, pitting, or excessive wear. Replace the gear as required.

d. Installation.

(1) Position the crankshaft gear on rear end of crankshaft with flat finished hub of the gear facing the cylinder block, and the bolt holes in the gear alined with the tapped holes in the crankshaft flange.

NOTE

One bolt hole is offset and the gear will aline in only one position.

(2) Aline the timing mark "R" on gear tooth with corresponding mark on idler gear (fig. 3-43).

(3) Insert the six screws (11, fig. 3-45) and lockwashers (12) through the crankshaft gear and into the tapped crankshaft flange. Draw the gear tight against the shoulder on the crankshaft. Tighten the screws to 35-39 ft-lb. torque.

(4) Check backlash with idler gear. Backlash should be within 0.003-0.008 inch range.

(5) Replace the flywheel housing (para 3-60).

Section XVII. CRANKSHAFT, GEARS AND MAIN BEARING

3-67. General

The crankshaft is a one-piece forging and is heat treated to insure strength and durability. The main and connecting rod bearing journal surfaces are induction hardened. Complete static and dynamic balance of the crankshaft is achieved by counterweights incorporated in the crankshaft design. Crankshaft thrust is taken through two-piece washers on each side of the rear main bearing. Main sleeve bearings are the procision-fit type, and are replaceable with machining. The upper sleeve bearing is seated in the main bearing cap. The bearing caps are marked in sequence, 1 through 4, with matching numbers stamped toward the blower side on the crankcase bearings supports. Each bearing cap must be installed in its same original position and must register with a milled slot in the crankcase to prevent sideways movement when bolted in place. Lower bearing shells have no oil grooves; therefore, *the upper and lower bearing shells must not be interchanged.*

3-68. Crankshaft, Gears, and Main Bearings

a. Removal.

(1) Remove the engine (para 2-7).

(2) Remove the cylinder head assembly (para 3-23).

(3) Remove the flywheel housing (para 3-60).

(4) Remove the connecting rods and pistons (para 3-32).

(5) Remove the crankshaft timing gear (para 3-66), and oil seal (8, fig. 3-45).

(6) Remove the bearing cap bolts (28, fig. 3-46), lockwashers (29), and bearing caps (30).

(7) Remove the deflector (15, fig. 3-45) from the front end of the crankshaft (4).

(8) Remove the thrust washers (5) and pins (13) from the rear main bearing cap.

(9) Remove the crankshaft (4) from the cylinder block.

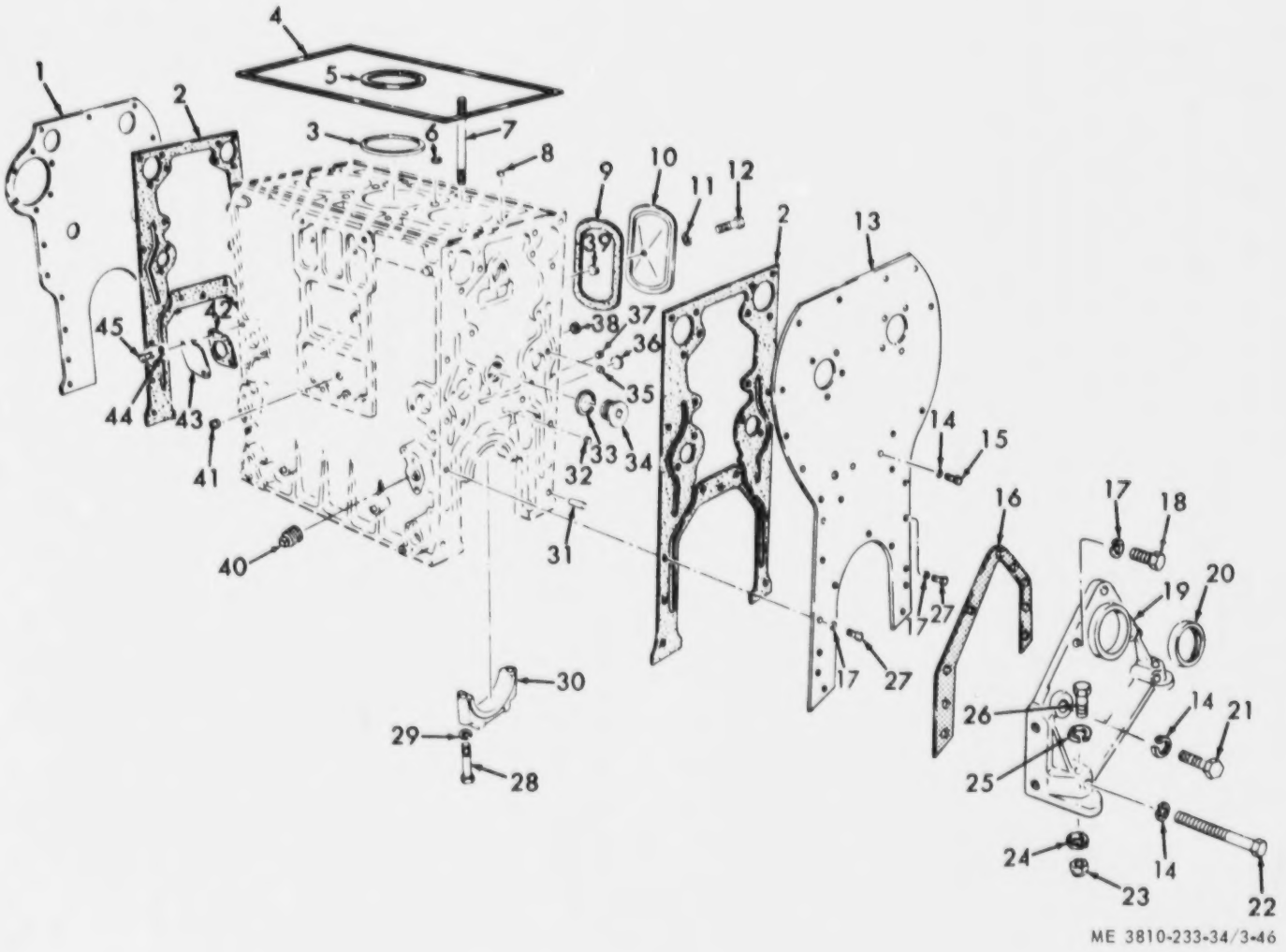


Figure 3-46. Cylinder block, exploded view.

Key to figure 3-46:

1 Plate
2 Gasket
3 Insert
4 Ring
5 Gasket
6 Ring
7 Stud
8 Ring
9 Gasket
10 Cover
11 Gasket
12 Screw
13 Plate
14 Washer
15 Screw
16 Gasket
17 Washer
18 Screw
19 Cover
20 Seal
21 Screw
22 Screw
23 Nut
24 Washer
25 Washer
26 Screw
27 Screw
28 Bolt
29 Washer
30 Cap
31 Pin
32 Pin
33 Gasket
34 Plug
35 Plug
36 Plug
37 Plug
38 Plug
39 Plug
40 Plug
41 Plug
42 Gasket
43 Cover
44 Washer
45 Bolt

b. Disassembly.

(1) Remove the oil pump drive gear (1) and key (3) from the crankshaft (4).

(2) Remove the sleeve bearings (7) from the crankcase and bearing caps.

(3) Remove the pipe plugs (16) and pins (10).

c. Cleaning, Inspection, and Repair.

(1) Clean the crankshaft assembly with steam or an approved cleaning solvent. Be sure all foreign material is removed from the oil passages. Dry the crankshaft and component parts with compressed air and apply a film of clean engine oil to prevent rusting.

(2) Inspect the crankshaft runout. If the runout exceeds that in table 1-4, replace the crankshaft.

(3) Inspect each bearing journal for evidence of a raised ridge around the circumference of the journal in line with the oilhole. If the ridge is 0.002 inch or more in height, remove before installing new bearings. Inspect each journal for taper and out-of-round condition.

(4) Inspect all the surfaces of the crankshaft for cracks. Inspect particularly for cracks which start at an oilhole.

(5) Inspect the keyways for evidence of cracks or worn condition.

(6) Inspect the rear oil seal area on the crankshaft for grooves or roughness.

(7) Inspect the crankshaft grinding.

(a) If the crankshaft is worn so that the maximum journal-to-bearing half clearance, with new halves, or the maximum taper or out-of-round exceeds the values in table 1-4, metallize the crankshaft and regrind to standard size.

(b) Be sure the fillets at the end of the crankshaft journals have 0.130 to 0.160-inch radius and are free of scratches.

(c) Be sure the oilholes in the journal are smooth and have a radius of approximately 3 / 32-inch at the edge of the hole.

(8) Inspect the main bearings.

(a) Inspect the main bearing halves for scoring, pitting chipping, cracking, or signs of overheating. Inspect the back of the sleeve bearings for bright spots, which indicate they have been moving in the main bearing caps or crankcase.

(b) If any of the above indications are present, replace the sleeve bearing. The clearance between the sleeve bearing and the journal should be from 0.0014 to 0.0044 inch.

NOTE

Main bearing halves should not be replaced separately. If bearing halves require replacement, all new halves, both upper and lower, must be replaced.

(9) Inspect the crankcase timing gear and oil pump drive gear for chipped teeth and cracks.

(10) Inspect the oil seal and oil deflector for cracks and smoothness.

(11) Inspect all applicable parts for damaged threads. Replace the front cover gasket and defective parts.

d. Assembly.

(1) Install the two pins (10) in the flange of the crankshaft (4).

(2) Install the four pins (13) in the rear main bearing cap.

(3) Install the oil pump drive gear (1) with woodruff key (3) on the front end of the crankshaft. Make sure the chamfer on the gear is positioned toward the counterweight of the crankshaft.

e. Installation.

(1) Install the upper crankshaft sleeve bearings (6) in place in the cylinder block.

(2) Apply clean engine oil to all crankshaft journals and set the crankshaft in place in the cylinder block.

(3) Install the upper halves of the rear main bearing thrust washers (5) on each side of the main bearing and the dowelled lower halves on each side of the rear main bearing cap.

(4) Install the lower crankshaft sleeve bearings (14) in the bearing caps and secure with the bolts and lockwashers. Tighten the bolts snugly, then tap the bearing caps to aline the bearing halves. Tighten the cap bolts to 180 to 190 ft-lb. torque.

NOTE

If the bearings have been properly installed, the crankshaft will turn freely with all main bearing caps bolted tight.

(5) Measure the crankshaft end play at the thrust washers according to the measurements listed in table 1-4. Insufficient clearance will usually denote misalinement of the rear main

bearing. Loosen the bearing cap and retighten, as described in (4) above.

(6) Install the dirt and liquid deflector (15, fig. 3-45) flush against the oil pump drive gear (1).

(7) Install the pistons and connecting rods (para 3-32).

(8) Install the crankshaft timing gear (para 3-66).

(9) Install the flywheel housing (para 3-60).

(10) Install the cylinder head assembly (para 3-23).

(11) Install the engine (para 2-7).

Section XVIII. CYLINDER BLOCK, END PLATES, AND LINERS

3-69. General

The cylinder block and crankcase, which is the main structural part of the engine, is a boxlike, one-piece casting made of alloy cast iron. Cylinder bores are fitted with cylinder liners, into which a number of air inlet ports are drilled. The liners are of the replaceable type. The upper halves of the main bearing seats are cast integrally with the block. Flat end plates, bolted to each end of the cylinder block, permit attachment to the flywheel housing at the rear front. The block has drilled passages for carrying lubricating oil to all moving parts. These eliminate oil tubing and connections.

NOTE

The cylinder liners are functionally and physically associated with the cylinder block but are normally supplied as a component part of a cylinder kit which includes a piston assembly.

3-70. Removal and Disassembly

a. Removal.

(1) Remove the engine (para 2-7).

(2) Remove the oil pan and oil pump (para 3-27 and 3-28).

(3) Remove the cylinder head assembly (para 3-23).

(4) Remove the pistons and connecting rods (para 3-32).

(5) Remove the flywheel and flywheel housing (para 3-59 and 3-60).

(6) Remove the blower and blower drive (para 3-39 and 3-40).

(7) Remove the camshaft and balance shaft (para 3-63).

(8) Remove the gear train (para 3-65).

(9) Remove the crankshaft and main bearings (para 3-68).

b. Disassembly.

(1) Remove the cylinder liner compression gasket (5, fig. 3-46) from the top of the cylinder liner (fig. 3-22). The cylinder liners are a loose fit in the cylinder block assembly, but after the engine has been in service for an extended period of time, it may be necessary to use a cylinder liner removing tool when removing the liners. If the liners are tight, remove them with a suitable tool. Repeat the procedure for all cylinder liners. Remove the cylinder liner inserts (3, fig. 3-46) from the counterbore.

(2) Remove the screws (18, 21, and 22) and lockwashers (14 and 17) that attach the crankshaft front cover (19) to the front end plate and cylinder block.

(3) Remove the front cover (19) and gasket (16). Remove the oil seal (20) from the front cover (19).

(4) Remove the screws (15 and 27) and lockwashers (14 and 17) that secure the front end plate (13) to the cylinder block assembly. Lift the end plate off the two dowel pins (31), near the bottom of the cylinder block, and remove the gasket (2). Remove the cylinder block rear end plate (1) and gasket (2) in the same manner.

(5) Remove the eight studs (7) from the cylinder block assembly.

(6) Remove the four dowel pins (31) from the front and rear of the cylinder block assembly.

(7) Remove the four plugs (34) and gaskets (33) from the front and rear of the cylinder block assembly.

(8) Remove the two bolts (45) and lockwashers (44) that secure the water hole cover (43) to the cylinder block assembly and remove the cover and gasket (42).

(9) Remove the water hole gaskets (6), seal rings (8), and water and oil gaskets from the recess in the top of the cylinder block assembly.

(10) Remove the pipe plug (34, 35, 37, 38, 39, 40, and 41) and expansion plugs (36) from the cylinder block assembly.

(11) Remove the screw (12) and copper gasket (11) that secure the hand hole cover (10) to the cylinder block assembly and remove the hand hole cover and gasket (9).

(12) Remove the cylinder head oil seal ring (4) from the cylinder block assembly.

3-71. Cleaning, Inspection, and Repair.

a. Cylinder Block.

(1) Remove the grease by agitating the block in an approved cleaning solvent and rinse with hot water or steam clean, to remove the solvent. After the block is inspected, dip it in rust preventive; otherwise the castings, free from grease and oil, will rust immediately when exposed to air.

NOTE

Completely clean all traces of rust preventive from the block before reassembling.

(2) Seal all but one of the water inlets and outlets. Immerse the block in water at a temperature of 180° to 200°F. Apply 80 to 100 psi air pressure to the water jacket and check for bubbles indicating cracks or leaks in the cylinder block. Remove the cylinder block from the tank and blow out the passages with dry, compressed air. Replace the block if cracked.

(3) Smooth down any nicks or raise areas on the eight studs (7). The top face of the cylinder block must not vary over 0.003 inch transversely and not over 0.009 inch longitudinally. If it is necessary to machine the top face of the cylinder block, do not remove more than 0.008 inch. The amount removed should be stamped on the face of the block.

CAUTION

The minimum distance from the center line of the crankshaft to the cylinder block is 16.176 inches.

(4) Deepen the counterbores and grooves in the cylinder block, for the water and oil gaskets and washers, the same amount as was removed from the top of the cylinder block. Do not deepen the counterbores for the cylinder liners as 0.004 inch and 0.008 inch undersize inserts are available. The blower mounting pad must not vary over 0.004 inch over its surface.

(5) Inspect the eight studs (7) for stretching or damaged threads; replace if defective.

(6) Inspect the main bearing bore inside diameter with the main bearing caps fastened in place with the proper torque (para 3-68). Standard bore diameter is 3.8120 to 3.8130 inches.

(7) Inspect the main bearing bores for longitudinal alinement with the main bearing caps in place. Use an alinement bar which is 0.00075 inch less in diameter than the diameter of the smallest main bearing bore. If the bores are properly alined, the alining bar can be turned with a 15-inch wrench with the bearing caps tightened to 110 ft-lb. torque. Main bearing bores, which are out of alinement, must be rebored. However, do not remove more than 0.001 inch of stock from any bore. If the bearing bores are more than 0.001 inch out of alinement, or out-of-round, replace the cylinder block.

(8) Inspect the cylinder counterbores for squareness and the proper depth and diameter. Counterbores should be from 5.0460 to 5.0485-inches diameter and 0.4785 to 0.4795-inch depth. Counterbored surfaces must be square with the cylinder bore within 0.001 inch. The depth cannot vary more than 0.001 inch around the entire circumference.

b. End Plates.

(1) Remove all traces of the old gasket from the surface of the end plates. Clean the end plates in an approved cleaning solvent and dry with a clean, dry cloth.

(2) Inspect both end plates for smoothness and flatness. Remove nicks, dents, or damaging marks which would prevent a tight seal between the surfaces of the cylinder block and the end plates and the flywheel housing and the end plates. Inspect the tapped holes in the end plate for elongation; replace the end plate if defective. Replace the end plate gaskets. Replace any damaged bolts and lockwashers.

c. Cylinder Liners.

(1) Clean the liners with an approved cleaning solvent. It may be necessary to soak the liners in solvent for a period of time to loosen the foreign material around the liner ports. After the liners are cleaned thoroughly, inspect for any burrs at the liner ports and remove them with 250-grit emery paper. Neglecting to remove burrs can result in early failure of the piston and rings.

(2) Inspect each cylinder liner for cracks or scoring; replace a defective liner. Inspect the outside diameters, taper, and out-of-round (table 1-4).

d. Handhole Covers. Clean the handhole covers with an approved cleaning solvent and dry thoroughly. Inspect for cracks, dents, or other damage. Inspect all applicable parts for damaged threads. Replace all gaskets and defective parts.

e. Cylinder Bores.

(1) The fit of a liner depends partly upon the condition of the bore before honing. Distortion may cause low spots that will not clean up. A low spot is not objectionable above the ports if it does not exceed 1¼ inch or the size of a half dollar. Larger spots are permissible below the ports. The hone, selection of hone stones, and method of honing are important especially when truing distorted bores.

(2) Use No. 180 grit stone for rough honing and No. 280 grit stone for the finishing. Liners are fitted from 0.0005 to 0.0025 inch loose.

3-72. Assembly and Installation

a. Assembly.

(1) Wipe the inside and outside of the cylinder liner (fig. 3-22) and be sure the bore in the cylinder is clean.

(2) Position the cylinder liner inserts into the counterbore of the cylinder liner flange in the cylinder block.

(3) Push the cylinder liner into the cylinder block assembly. When in place, the top face of the cylinder liner upper flange should be from 0.046 to 0.050 inch below the top surface of the cylinder block. Measure the distance between the top of the

cylinder liner to the top of the cylinder block. Repeat this procedure for all liners.

CAUTION

There must not be over 0.002 inch difference in height below the top of the cylinder block between any two cylinder liners.

(4) Position a cylinder liner compression gasket (fig. 3-22) on the upper side of each cylinder liner flange.

(5) Install the plugs (34, fig. 3-46) with new gaskets (33) in each end of the cylinder block assembly.

(6) Be sure both surfaces of each end plate (1 and 13) are clean. The surfaces must also be smooth and flat.

(7) Position new gaskets (2) at each end of the cylinder block assembly and apply an approved cement to the outer surface of each gasket and end plates (1 and 13).

(8) Using dowel pins (31), set the front end plate (13) next to the cylinder block and secure the end plate with the lockwashers (14 and 17) and screws (15 and 27). Do not tighten the screws.

(9) Using the dowel pins install the rear end plate gasket and rear end plate as described in (8) above.

(10) Apply a coat of an approved cement on the water hole cover gasket (42) and position on the cylinder block assembly. Install the water hole cover (43) and secure with the bolts (45) and lockwashers (44).

(11) Install the studs (7) in the cylinder block assembly and tighten to 175 to 185 ft-lb. torque. The height of the studs above the cylinder block should be $4\frac{3}{8} \pm 1/16$ inch.

(12) Install the water hole gaskets (6), seal rings (8), and water and oil gaskets in the recess in the cylinder block assembly.

(13) Install the pipe plugs (34, 35, 37, 38, 39, 40, and 41) and expansion plugs (36) in the cylinder block assembly.

(14) Install the hand hole cover (10) with gasket (9) on the cylinder block assembly and secure with the screw (12) and copper gasket (11).

(15) Install the cylinder head oil seal ring (4) in the recess in the cylinder block assembly.

(16) Install the crankshaft and main bearings (para 3-68).

(17) Install the camshaft and balance shaft (para 3-63).

(18) Install the gear train (para 3-65).

(19) Lubricate the lip of the oil seal (20, fig. 3-46) lightly, and press carefully into the front cover (19).

(20) Install a new gasket (16), and front cover (19). Secure with screws (18, 21, and 22) and lockwashers (17 and 14). Tighten the $\frac{3}{8}$-inch screws (18 and 21) to 25 to 30 ft-lb. torque, and the $\frac{1}{2}$-inch screws (22) to 80-90 ft-lb. torque.

(21) Install the water hole gaskets (6), seal rings (8) and water and oil gaskets in the recess in the cylinder block assembly.

(22) Install the blower and blower drive (para 3-39 and 3-40).

(23) Install the pistons and connecting rods (para 3-32).

(24) Install the cylinder head assembly (para 3-23).

(25) Install the oil pump and oil pan (para 3-27 and 3-28).

b. Installation. Install the engine (para 2-7).

Section XIX. HYDRAULIC POWER STEERING PUMP

3-73. General

The pump is mounted at the rear of the engine on the flywheel housing by means of an adapter plate, and is driven by an accessory drive assembly connected to the balance shaft gear. The pump is conventional in design for relatively low volume, high-pressure hydraulic pumps, and is equipped with an externally-mounted reservoir containing the fluid required to operate the rear steering system of the crane.

3-74. Hydraulic Steering Pump

a. Removal.

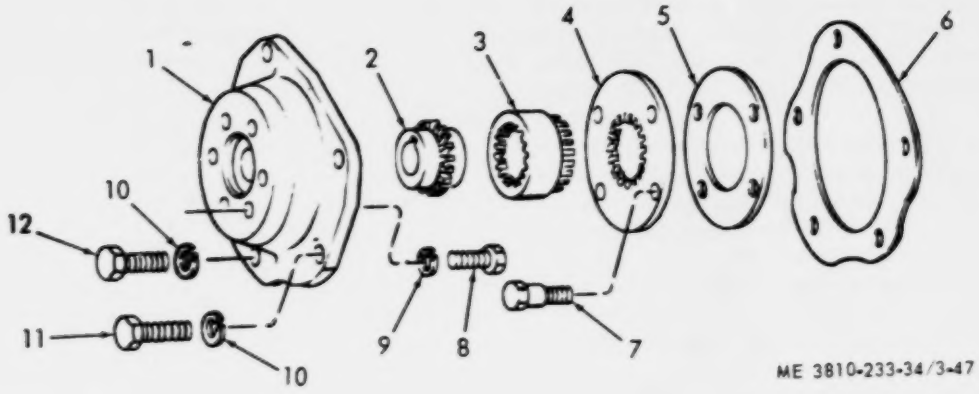
(1) Drain the hydraulic fluid from the rear steering system and disconnect the two hose connections.

(2) Remove the five screws (11 and 12), and lockwashers (10) that attach the adapter to the flywheel housing.

(3) Remove the two screws (8, fig. 3-47) and lockwashers (9) that attach the pump to the adapter (1). Remove the pump.

(4) Remove the adapter (1) and gasket (6) from the flywheel housing.

(5) Remove the four bolts (7), drive disc (4), spacer (5), sprocket (2), and drive coupling (3).



1 Adapter
2 Sprocket
3 Coupling
4 Drive gear
5 Spacer
6 Gasket
7 Shouldered bolt
8 Bolt
9 Lockwasher
10 Lockwasher
11 Capscrew
12 Capscrew

Figure 3-47. Pump drive components, exploded view.

b. Disassembly.

(1) Clamp pump mounting flange in vise. *Use protective jaws.*

(2) Remove the wing nut (1, fig. 3-48), lockwasher (2), washer (3), cover (4), and gasket (5) from the reservoir (16).

(3) Remove cotter pin (6) from reservoir stud (11). Remove washer (7), spring (8), retainer (9), and filter element (10) from the stud.

(4) Remove stud and nut (14). Remove capscrews (12), baffle (13), and reinforcing plate (15). Remove reservoir (16) and gasket (17) from pump cover (18).

(5) Remove capscrews (38) and cover (18) from the pump body (24).

(6) Remove spring (19) and pressure plate (20) from body (24). Remove pump ring (21), locating pins (33), rotor (22), and vanes (32) from body.

CAUTION

Note position of rotation arrow on pump ring.

(7) Place the cover (18) in a vise with protective jaws. Drive out retaining pin (39). Remove plug (37), packing (36), and valve (35), and spring (34) from cover.

(8) Remove the pump drive sprocket from the drive shaft.

(9) Support the shaft end of the pump body in an arbor press and remove the shaft assembly from the body.

(10) Remove the retaining rings (26 and 30) and bearing (27) from the shaft.

(11) Remove the shaft seal (25) from the body.

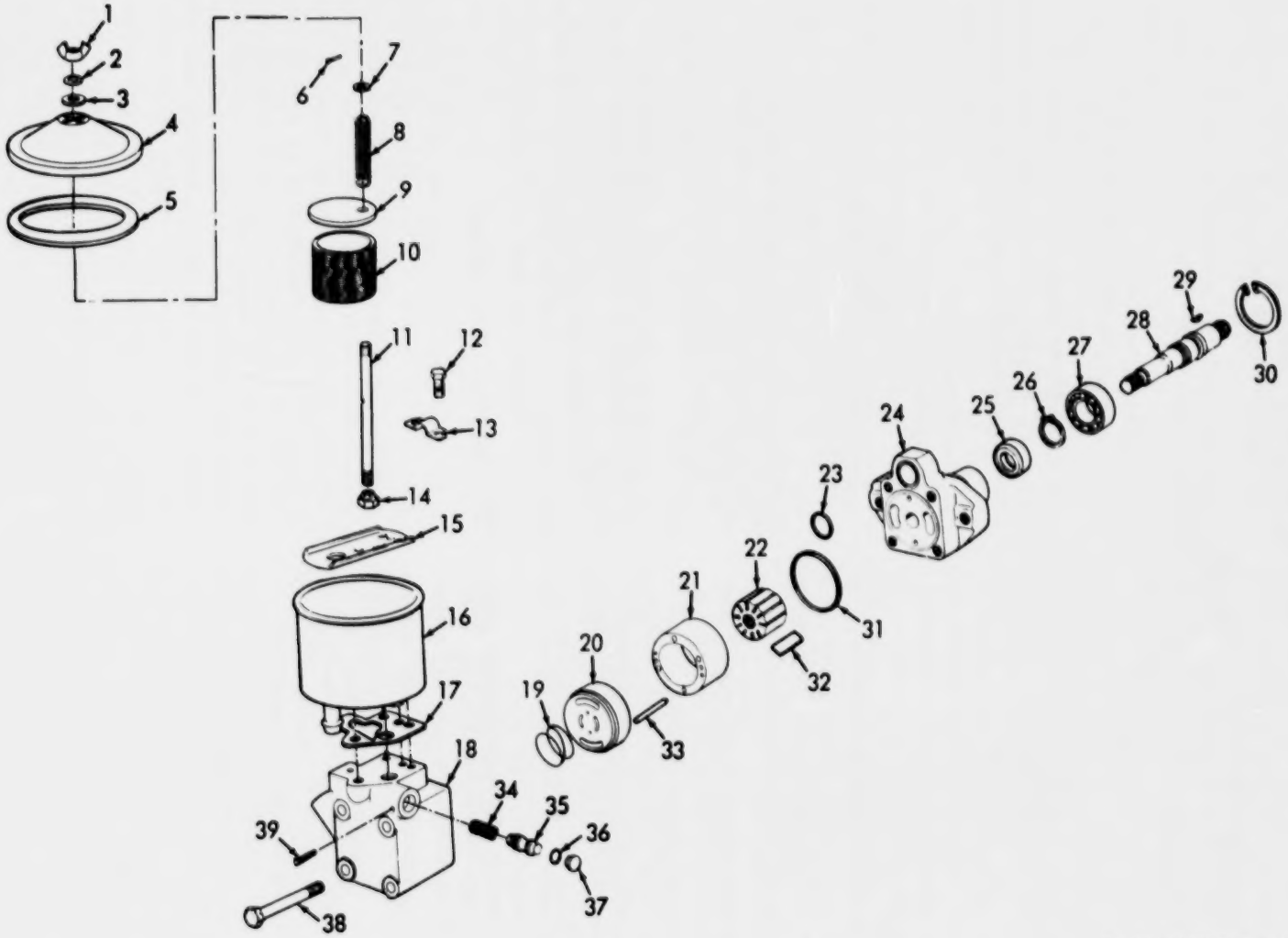


Figure 3-48. Hydraulic steering pump, exploded view.

Key to figure 3-48:

1 Wing nut
2 Lockwasher
3 Washer
4 Cover
5 Gasket
6 Cotter pin
7 Washer
8 Spring
9 Retainer
10 Filter element
11 Stud
12 Capscrew (2)
13 Baffle
14 Nut
15 Reinforcing plate
16 Reservoir
17 Gasket
18 Cover
19 Spring
20 Pressure plate
21 Ring
22 Rotor
23 Preformed packing
24 Body
25 Shaft seal
26 Retaining ring
27 Bearing
28 Shaft
29 Key
30 Retaining ring
31 Preformed packing
32 Vane (10)
33 Pin (2)
34 Spring
35 Control valve
36 Preformed packing
37 Plug
38 Capscrew
39 Pin

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly.

NOTE

Discard all gaskets and preformed packing and replace with new units when assembling. Gasket and cartridge kits are available for repair.

(2) Inspect all surfaces of parts that are subject to wear. Remove light scoring by lapping, otherwise, replace respective parts. Inspect edges of vanes (32) for wear. Excessive play in slots or burred edges will necessitate the replacement of the cartridge kit.

(3) Install the control valve (35) in the cover (18). Replace if any binding or scoring is observed.

(4) Install a new shaft seal (25) in the cover. Do not overpress seal.

NOTE

Coat all parts with clean hydraulic oil prior to assembly.

d. Assembly.

(1) Assemble pump in reverse order of disassembly, using new gasket and preformed packing. Make sure the ring (21) is installed with the arrow pointing in correct direction of rotation, and with the chamfered edge of the rotor (22) toward the pump body (24).

(2) Install the cover (18) and cover capscrews (38). Tighten capscrews to a torque of 25-30 ft-lbs.

e. Installation.

(1) Install the drive gear (4, fig. 3-47) and spacer (5) on the balance shaft gear. Attach with the four bolts (7).

(2) Install the sprocket (2), drive coupling (3), gasket (6), and adapter (1).

(3) Engage the pump drive shaft in the drive coupling and install the pump assembly on the adapter (1) with the bolts (8) and lockwasher (9).

NOTE

Tighten all bolts to standard torque values specified in table 1-1.

(4) Connect the hose to the pump assembly and service the system in accordance with the current lubrication order.

NOTE

Rebuild and overhaul procedures should be confined to parts replacement in view of assembly and components costs.

CHAPTER 4

REPAIR OF CRANE SUPERSTRUCTURE

Section I. INTRODUCTION

4-1. General

The crane superstructure consists of a sub-base mounting the upper turret assembly, ring gear, and boom swing drive assembly; the hydraulic rotary seal; the main boom and hoist assembly; the boom head, hook block, trouble light, crane floodlights, and the boom hoist and boom extension cylinders.

4-2. Removal

NOTE

Removal of the hook block and boom head and boom extension, and main boom prior to the removal of the upper turret assembly is not mandatory, but is desirable prior to removal of the boom hoist cylinders. Removal of the hoist drive assembly may also be advantageous.

a. Remove the hook block (TM 5-3810-233-12).

b. Remove boom head assembly (para 4-3).

c. Remove the boom extension head assembly, boom head extension, and cylinder extension (para 4-3, 4-4, and 4-5).

d. Remove the boom hoist cylinders (TM 5-3810-233-12).

e. Remove the main boom and boom extension (TM 5-3810-233-12).

f. Remove the hoist drive motor and hoist gear box assembly (para 4-9 and 4-10).

g. Remove the crane superstructure.

Section II. SUPERSTRUCTURE

4-3. Boom Head Assembly

a. Removal. Remove the boom head assembly (TM 5-3810-233-12).

b. Disassembly.

(1) Remove the nuts (6, fig. 4-1), lockwashers (5), bolts (12), and spacers (4).

(2) Remove the nut (7) and shaft (10).

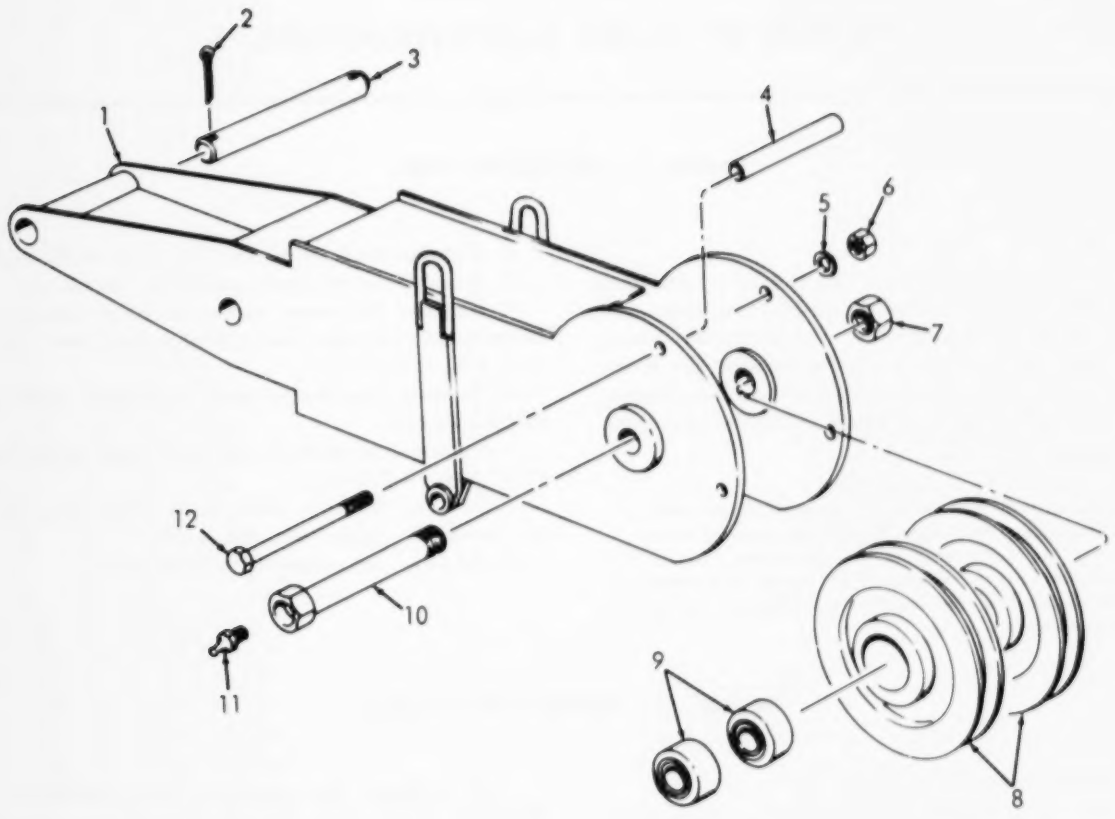
(3) Remove the sheaves (8).

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly with compressed air.

(2) Inspect the sheaves for cracked or damaged edges, and excessive wear in grooves. Replace as required.

(3) Rotate the inner bearing races (9) by hand. If roughness is detected or excessive play encountered, press out the bearing assembly from the sheave and replace with new bearings.



ME 3810-233-34/4-1

1 Head
2 Cotter pin
3 Pin
4 Spacer
5 Lockwasher
6 Hex nut
7 Locknut
8 Sheave
9 Bearing
10 Shaft
11 Lub fitting
12 Screw

Figure 4-1. Boom head assembly, exploded view.

d. Reassembly. Reassemble the boom head assembly in reverse order of disassembly.

e. Installation. Install the boom head assembly (TM 5-3810-233-12).

4-4. Boom Head Extension

The boom head extension is identical in construction to the boom head assembly except for length. All instructions for the boom head assembly are applicable to the extension.

4-5. Boom Extension Cylinder

a. Removal.

(1) Slide telescoping section (3, fig. 4-4) forward and remove cotter pin (1, fig. 4-2) and extension cylinder piston anchor pin (13).

(2) Remove nuts, lockwashers and bolts (fig. 4-2(1).

(3) Disconnect and cap hydraulic lines and ports (fig. 4-2(1).

(4) Remove boom extension cylinder using a hoist to support the cylinder.

b. Disassembly.

(1) Unscrew the head (18, fig. 4-2) and remove the piston rod assembly from the body (10).

(2) Remove the locknut (11) from the piston rod (14). Remove packing, seals, gland and piston (22) from the piston rod.

(3) Remove the tube assembly (8) from the body (10).

(4) Remove the plug (23), packing (5), spring (24), and ball (25) from the body.

(5) Discard all seals and packing.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly.

(2) Inspect the body, rod and piston for scoring. Remove fine scoring with a lapping stone or fine crocus cloth. Replace deeply scored parts.

Figure 4-2. Boom extension cylinder, removal and installation. (sheet 1 of 2).

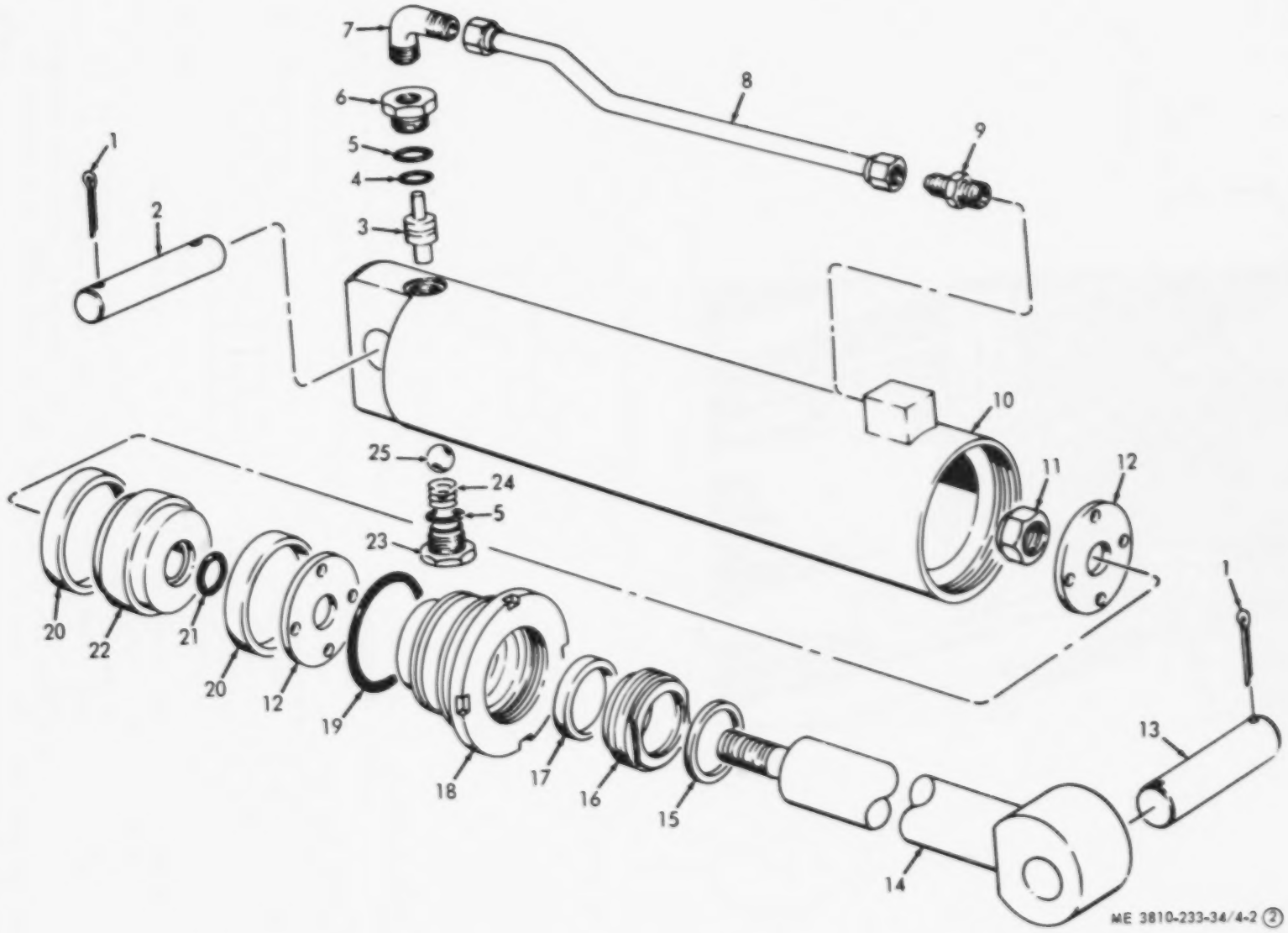


Figure 4-2. Boom extension cylinder, exploded view. (Sheet 2 of 2).

Key to figure 4-2:

1 Cotter pin
2 Pin
3 Pilot piston
4 Packing
5 Packing
6 Reducer
7 Elbow
8 Tube assy.
9 Connector
10 Body
11 Locknut
12 Plate
13 Pin
14 Rod
15 Rod wiper
16 Gland
17 Packing
18 Head
19 Seal
20 Packing
21 Packing
22 Piston
23 Plug
24 Spring
25 Steel ball

d. Assembly.

(1) Reassemble the piston rod assembly components in the reverse order of disassembly.

(2) Replace all packing and seals with new parts.

(3) Lubricate the piston rod assembly lightly with clean hydraulic fluid.

(4) Install the piston rod assembly in the body. Tighten the head (18) securely in the body.

e. Installation. Install the boom extension cylinder in reverse order of removal.

4-6. Boom Hoist Cylinder

a. Removal. Remove the boom hoist cylinder (s) (TM 5-3810-233-12).

b. Disassembly.

(1) Unscrew the head (17, fig. 4-3) from the body (7).

(2) Withdraw the piston and rod assembly from the body.

(3) Remove nut (6) and all components from the piston rod (12). Discard all packing.

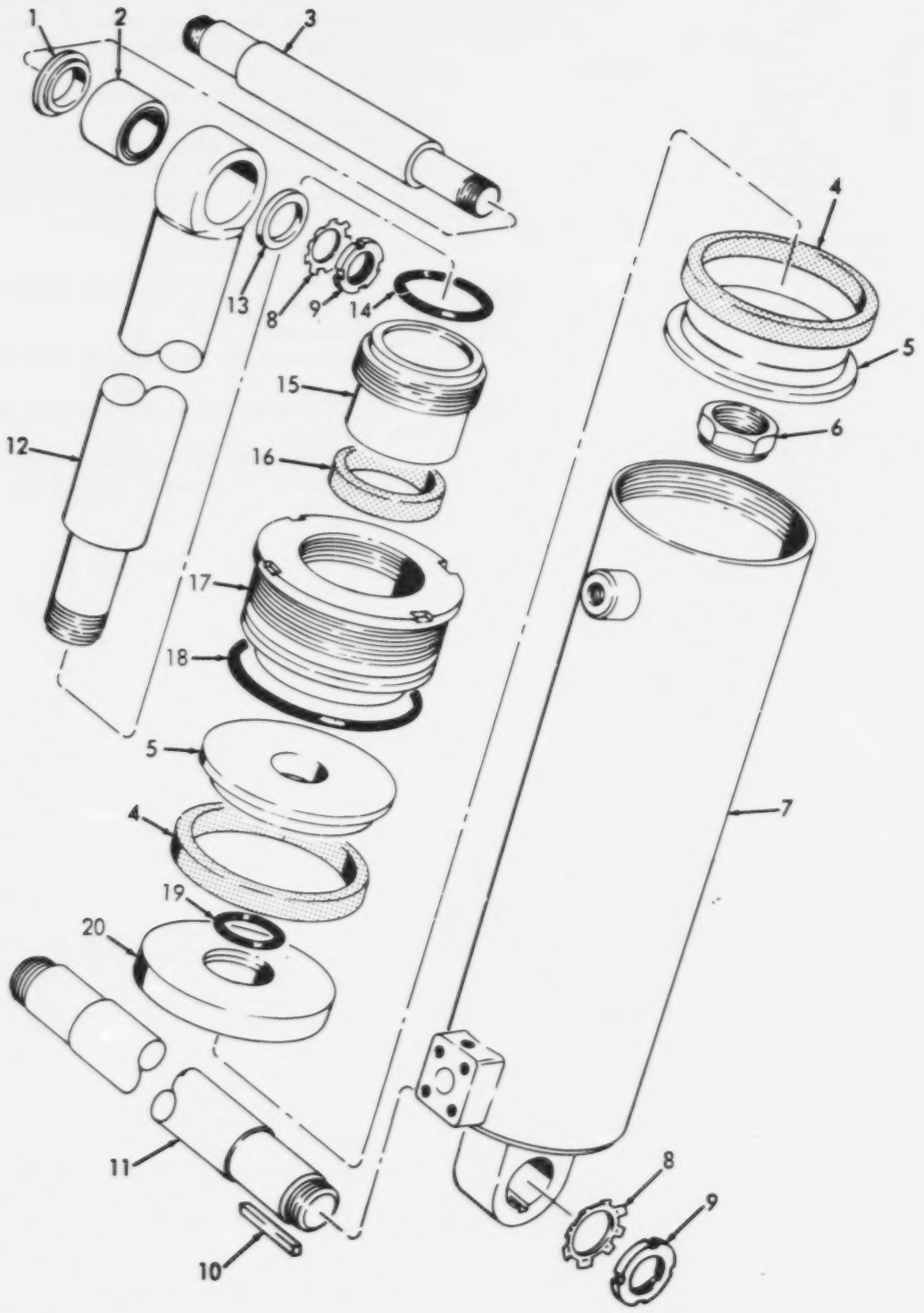


Figure 4-3. Hydraulic cylinder, boom hoist, exploded view.

Key to figure 4-3:

1 Spacer
2 Bearing
3 Shaft
4 Packing
5 Retainer
6 Locknut
7 Body
8 Key washer
9 Round nut
10 Key
11 Shaft
12 Rod
13 Washer
14 Wiper
15 Gland
16 Packing
17 Head
18 Packing
19 Packing
20 Piston

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly.

(2) Inspect the body, rod, and piston for scoring. Remove fine scoring marks with a lapping stone or fine crocus cloth. Replace deeply scored parts.

(3) Inspect anchor shafts (3 and 11) for wear. Replace as required.

d. Assembly.

(1) Install the washer (13), key washer (8), nut (9), wiper (14), gland (15), packing (16), stuffing box (17), packing (18), retainer (5), packing (4), packing (19), piston (20), and locknut (6) on the piston rod.

(2) Tighten assembly securely and lubricate lightly with clean hydraulic fluid. Install assembly in body (7) and tighten head (17) securely.

e. Installation. Install cylinder(s) (TM 5-3810-233-12).

4-7. Main Boom and Boom Assembly

a. Removal. Remove the main boom assembly (TM 5-3810-233-12).

b. Disassembly.

(1) Slide telescoping section (3, fig. 4-4) forward and remove cotter pin and extension cylinder piston anchor pin.

(2) Remove nuts (23), lockwashers (11), and capscrews (1).

(3) Remove boom extension cylinder.

(4) Remove capscrew (15), lockwasher (14), eccentric pin 16), and roller (13).

(5) Remove capscrews (10), lockwashers (11), retainers (8), and roller assembly (12) with bearings (7).

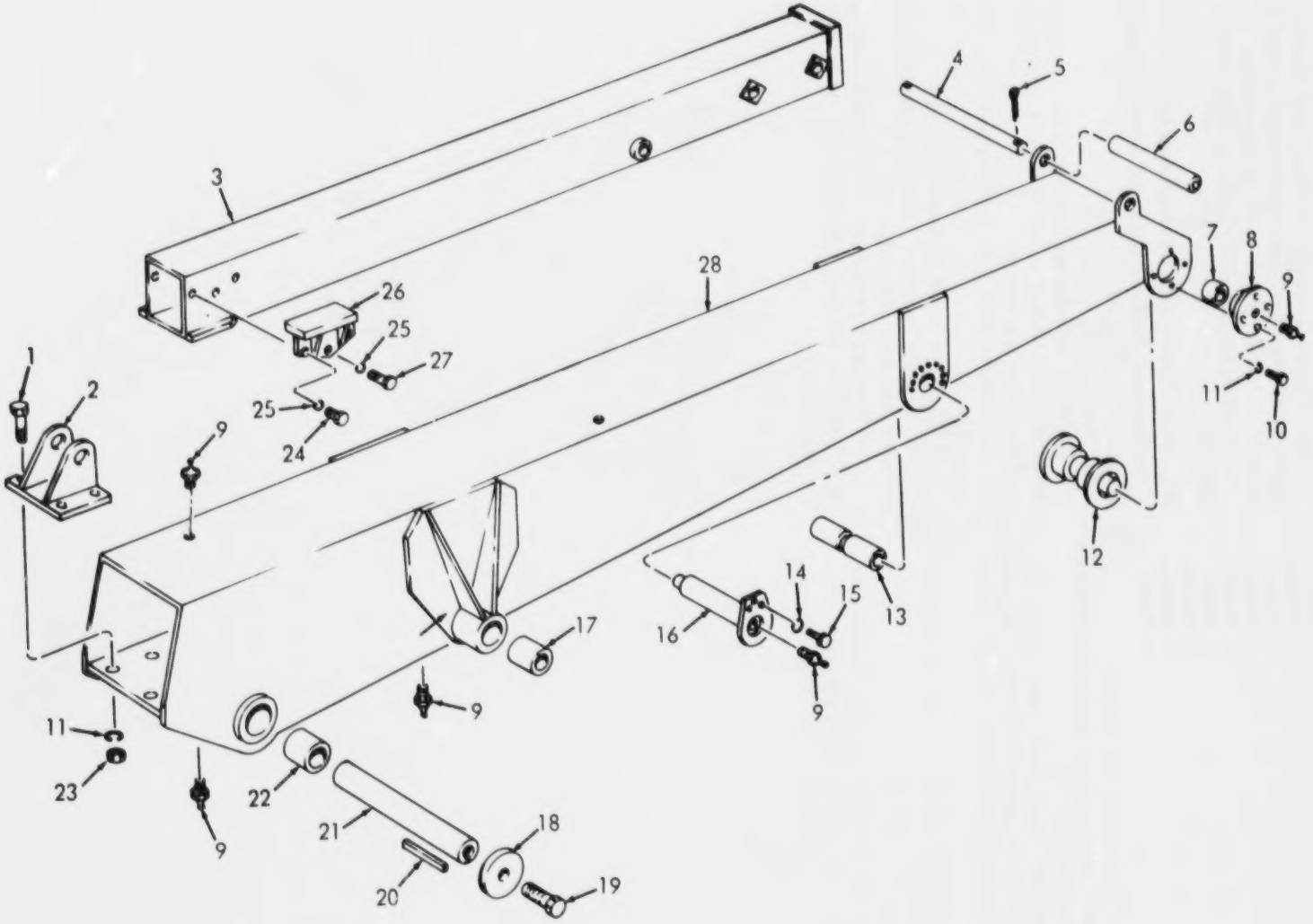


Figure 4-4. Main boom assembly, exploded view.

ME 3810-233-34/4-4

Key to figure 4-4:

1 Capscrew
2 Bracket
3 Telescoping section
4 Pin
5 Cotter pin
6 Roller
7 Bearing
8 Retainer
9 Lube fitting
10 Capscrew
11 Lockwasher
12 Roller
13 Roller
14 Lockwasher
15 Capscrew
16 Eccentric pin
17 Bushing
18 Washer
19 Capscrew
20 Key
21 Shaft
22 Bushing
23 Hex nut
24 Screw
25 Lockwasher
26 Wear shoe
27 Capscrew
28 Main boom

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved solvent.

(2) Inspect wear shoes (26) for excessive wear. Replace if worn excessively.

(3) Inspect bushings (22) for wear. If scored or worn sufficiently to allow vertical shaft movement approximating 1 / 16 inch, replace the bushings.

(4) Inspect the boom hoist cylinder shaft bushings (17) for wear. Replace if shaft movement vertically approximates 1 / 16 inch.

(5) Inspect the rollers (12) and bearings (7) for wear. Replace rollers if worn badly, and bearings if extremely loose.

(6) Inspect rollers (6) and (13) for excessive wear. Replace as required.

(7) Inspect shafts and pins for scoring and excessive wear. Replace as required.

d. Assembly. Assemble the main boom assembly in the reverse order of disassembly.

e. Installation. Install the main boom assembly on the crane (TM 5-3810-233-12).

Section III. HOIST DRIVE COMPONENTS

4-8. General

The hoist drive components consists basically of the hydraulic drive motor, and the hoist gear box and drum assembly. The hoist motor is under full power during hoisting and lowering to assure positive control of the crane load. The hydraulic fluid system is connected through a rotary seal unit to the revolving hydraulic elements. The gear box drive and drum assembly are sturdily-constructed units, designed to provide many hours of operation under severe operating conditions.

4-9. Hoist Drive Motor

a. Removal. Remove the hoist drive motor (TM 5-3810-233-12).

b. Disassembly.

NOTE

The hoist hydraulic motor and boom swing motor are identical. Disassembly; cleaning, inspection, and repair, and assembly instructions for the swing boom motor will be referenced to this paragraph.

(1) Remove the four capscrews (1, fig. 4-5) from the valve plate subassembly (2). Remove the valve plate (2) and gasket (6) from the housing (22).

(2) Turn the rotating group slightly to free it from the swash plate (25).

(3) Tilt the housing and remove the rotating group.

CAUTION

Do not separate the cylinder block (11) from the rotating group during removal from the housing.

(4) Remove the pistons (26) and shoe plate (27) from the cylinder block (11).

CAUTION

Handle the pistons carefully to avoid marring their polished surfaces.

(5) Remove the retainer ring (7), washers (8 and 10), and spring (9) from the cylinder block (11).

(6) Lift the swash plate (25) from the housing.

(7) Remove the retainer ring (17).

(8) Drive the shaft (16) and bearing (19) from the housing with a soft tip hammer.

(9) Remove the key (15), retainer ring (18), and bearing (19) from the shaft.

(10) Remove the washer (20) and seal (21) from the housing with the seal driving tool (fig. 2-1).

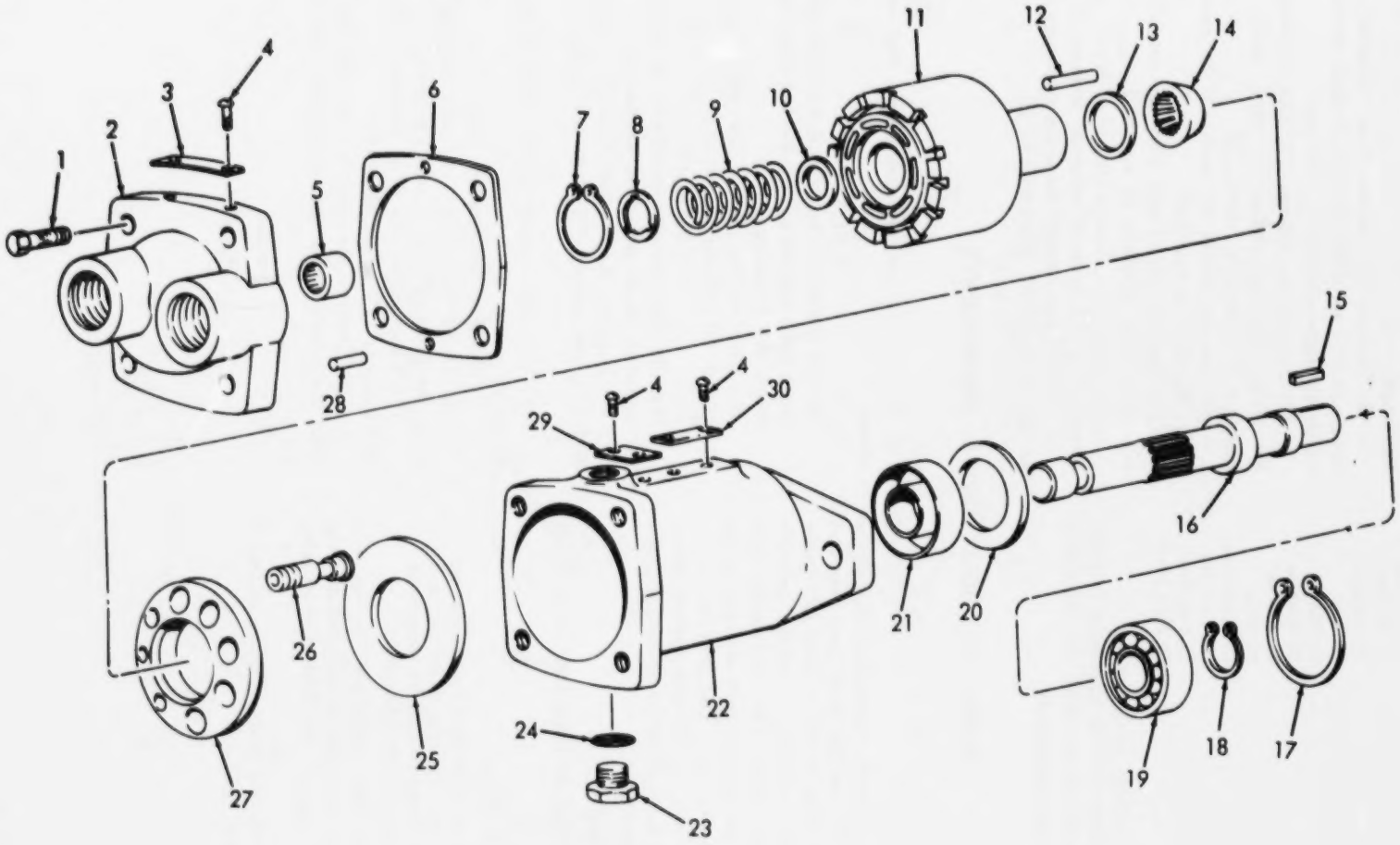


Figure 4-5. Hoist drive motor, exploded view.

Key to figure 4-5:

1 Screw
2 Valve plate
3 Rotation plate
4 Screw
5 Bearing
6 Gasket
7 Retainer
8 Washer
9 Spring
10 Washer
11 Cylinder block
12 Pin
13 Washer
14 Spherical washer
15 Key
16 Shaft
17 Retainer
18 Retainer
19 Bearing
20 Washer
21 Seal
22 Housing
23 Plug
24 Preformed packing
25 Swash plate
26 Piston
27 Shoe plate
28 Pin
29 Instruction plate
30 Name plate

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved solvent. Dry thoroughly and place on a clean surface for inspection.

(2) Inspect the bores and valve plate mating surface of the cylinder block for wear and scoring. If wear or scoring is discernible, replace the cylinder block.

NOTE

A rotating group kit and seal kit is available for the repair of the motor. Refer to parts listing for kit components.

(3) Inspect the swash plate (25) for wear and scoring. Minor defects and scoring may be removed with a lapping stone, but if 0.0004 inch removal is required, replace the plate.

(4) Inspect the bearings (5 and 19) for roughness or excessive play. Replace if necessary.

(5) Inspect the drive shaft (16) for scoring or wear in the shaft seal (21) area. Replace shaft if scored or worn appreciably.

d. Assembly. Assembly is basically the reverse of disassembly but extreme care should be exercised in assembly to insure correct performance. Use a new gasket (6), seal (21), and packing (24) when assembling.

(1) Coat all parts with a light film of clean hydraulic fluid.

(2) Install a new shaft seal (21) in the housing (22) and place washer (20) over the seal.

(3) Install bearing (19) and retainer ring (18) on the drive shaft (16). Fill the bearing one-half full with a good grade of high temperature ball bearing grease. Install the shaft and bearing in the housing and install retainer ring (17).

(4) Assemble ring, washers, and spring in cylinder block.

(5) Install the swash plate in housing with chamfered edge facing shaft seal.

(6) Place the cylinder block face down on a smooth clean surface. Insert the three pins (12) in the cylinder block (11). Grease the backup (13) and spherical (14) washers and place them on the pins.

(7) Place the nine pistons (26) in the shoe plate (27).

CAUTION

Do not allow the pistons to strike each other.

(8) Hold the shoe plate carefully and aline the pistons and slip them into the lubricated cylinder block.

(9) Hold the cylinder block and shoe plate carefully to keep the pins and washers, and other components intact; install the rotating group on the drive shaft. Rotate slightly to aid in alining splines of cylinder body and drive shaft.

(10) Replace valve plate (2) and gasket (6). Secure with capscrews (1) and tighten to a torque of 70-80 ft-lbs.

e. Installation. Install the hoist motor (TM 5-3810-233-12).

4-10. Hoist Gear Box and Drum Assembly

a. Removal. Remove the gear box and drum (TM 5-3810-233-12).

b. Disassembly.

(1) Remove capscrews (6, fig. 4-6), lockwashers (5), and cover plate (4).

(2) Remove capscrews (6), lockwashers (5), and cover (38).

(3) Pull the bearing (3) from the shaft (18).

(4) Pull the drum (1) from the shaft.

(5) Remove the capscrews (41), lockwashers (42), and cover (36).

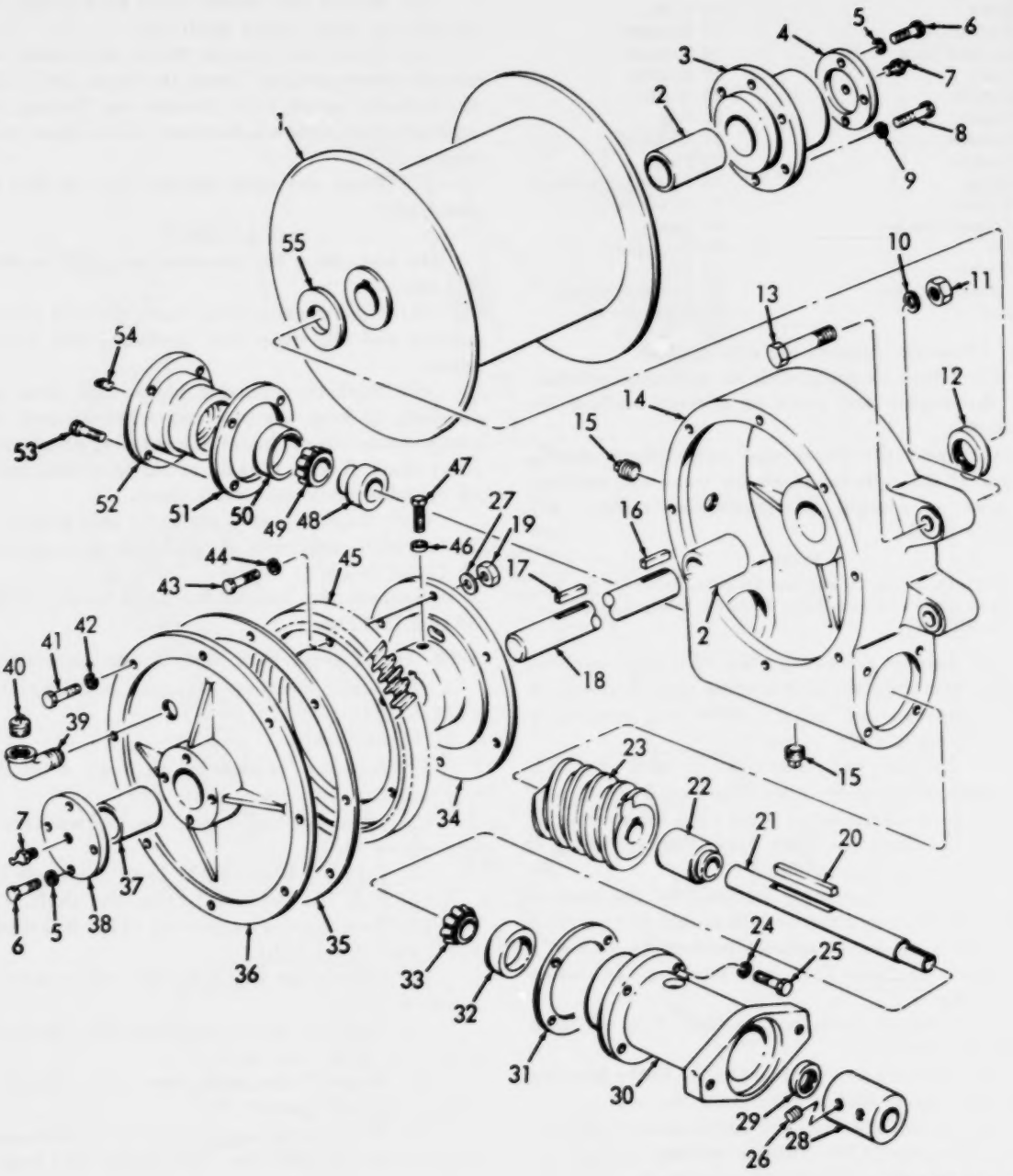
(6) Loosen the jam nut (46) and remove the setscrew (47).

(7) Remove the center plate (34) and worm gear (45) from the shaft.

(8) Remove the capscrews (53), closed end plug (52), and gasket (51).

(9) Remove the capscrews (25), lockwashers (24), motor adapter (30), and gasket (31) from the gear case (14).

(10) Remove the shaft (21), spacers (22 and 48), and worm (23) from the gear box.



ME 3810-233-34/4-6

1 Drum
2 Bushing
3 Bearing
4 Cover plate
5 Lockwasher
6 Screw
7 Lubrication fitting
8 Screw
9 Lockwasher
10 Lockwasher
11 Nut
12 Seal
13 Screw
14 Gear case
15 Pipe plug
16 Key
17 Key
18 Shaft
19 Nut
20 Key
21 Shaft
22 Spacer
23 Worm
24 Lockwasher
25 Screw
26 Setscrew
27 Washer
28 Coupling
29 Seal
30 Motor adapter
31 Gasket
32 Bearing cup
33 Bearing
34 Center plate
35 Gasket
36 Cover
37 Bushing
38 Cover
39 Street ell
40 Pipe plug
41 Screw
42 Lockwasher
43 Screw
44 Lockwasher
45 Worm gear
46 Nut
47 Setscrew
48 Spacer
49 Bearing
50 Bearing cup
51 Gasket
52 Closed end plug
53 Screw
54 Pipe plug
55 Thrust washer

Figure 4-6. Hoist gear box and drum assembly, exploded view.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved solvent. Dry thoroughly.

(2) Inspect the shafts (18 and 21) for scoring and wear.

(3) Inspect the bushings (2 and 37) for scoring and excessive wear. If play on drum shaft exceeds 0.015-0.020 inch, replace the bushings.

(4) Inspect the bronze worm gear teeth (45) for excessive wear by meshing the steel worm (23) with the worm gear. If end play of worm shaft exceeds 1 / 32 inch, replace the worm gear on the center plate (34) by removing the capscrews (43) and lockwashers (44). When replacing the worm gear, make sure that the capscrews are tightened firmly.

(5) Inspect the steel worm for scoring. Replace as required.

(6) Inspect the tapered roller bearings (33 and 49) for worn rollers and rough spots while rotating the bearings. Inspect the bearing cups (32 and 50) for rough spots. Replace as required.

(7) Inspect the keys (16, 17, and 20) for wear. If any are loose fitting in respective keyways, replace.

(8) Inspect the thrust washer (55) for wear. If badly worn or scored, replace.

(9) Remove the seal (29) from the motor adapter (30). Replace with new seal when assembling the unit.

d. Assembly. Assemble gear case and drum assembly in reverse order of disassembly. Replace seal (12) and gaskets (31 and 51) with new units.

e. Installation. Install the gear case and drum assembly (TM 5-3810-233-12).

Section IV. UPPER TURRET AND BOOM SWING COMPONENTS

4-11. General

The crane sub-base and superstructure must be removed before the boom swing motor, boom swing gear box, and rotary seal can be removed (para 4-2). The boom swing motor is identical with the hoist drive motor in design, and its disassembly and repair will be referenced to paragraph 4-9. The boom swing gear box is similar in design to the hoist gear box (para 4-10). The rotary seal unit and collector ring assembly provides hydraulic and electrical connections to the superstructure revolving elements.

4-12. Removal Points

a. Remove the crane superstructure (para 4-2).

b. Tag and disconnect the hydraulic piping at the boom swing motor (fig. 4-7) and at the base of the rotary seal unit (fig. 4-8). Remove the hydraulic lines.

c. Remove the bolts, rotary seal locking collar, and hydraulic lines to the rotary seal unit (fig. 4-8).

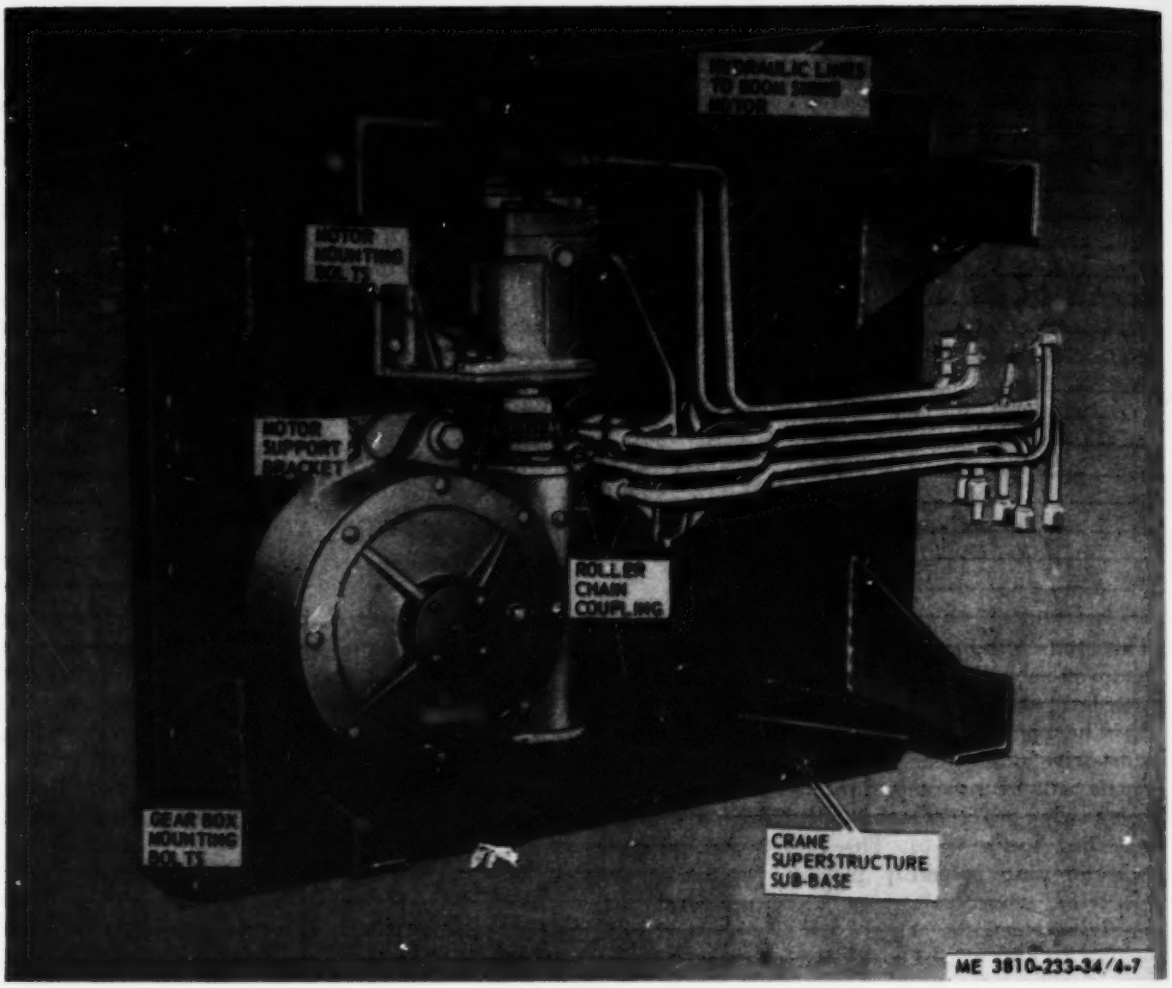


Figure 4-7. Boom swing motor and gear box removal.

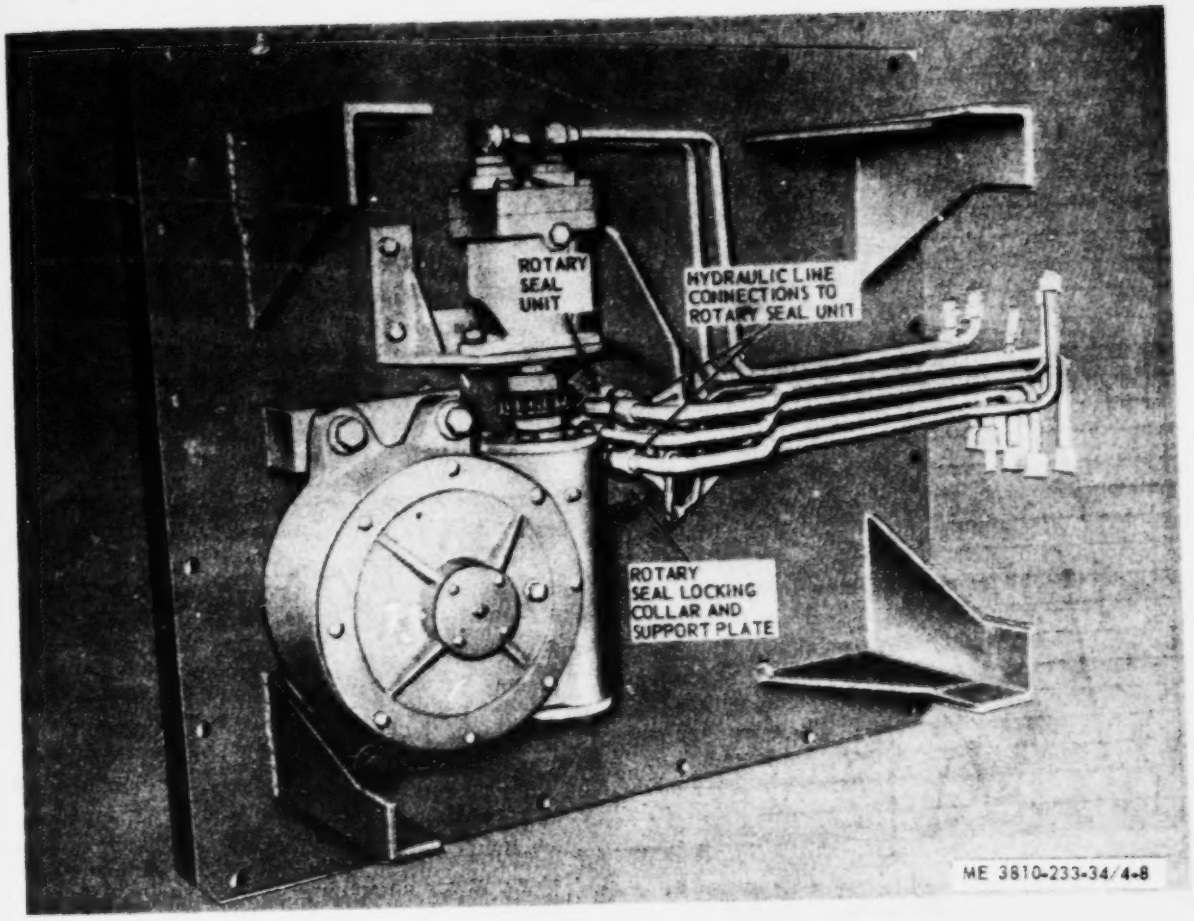

ROTARY SEAL UNIT
HYDRAULIC LINE CONNECTIONS TO ROTARY SEAL UNIT
ROTARY SEAL LOCKING COLLAR AND SUPPORT PLATE
ME 3810-233-34/4-8

Figure 4-8. Rotary seal unit removal.

4-13. Boom Swing Motor

a. Removal. Remove the boom swing motor (TM 5-3810-233-12).

b. Disassembly. Follow instructions given for hoist motor (para 4-9).

c. Cleaning, Inspection, and Repair. Follow instructions given for hoist motor (para 4-9).

d. Assembly. Follow instructions given for hoist motor (para 4-9).

e. Installation. Install the swing motor (TM 5-3810-233-12).

4-14. Boom Swing Gear Box

a. Removal. Remove the boom swing gear box (TM 5-3810-233-12).

b. Disassembly.

(1) Remove pinion gear (21, fig. 4-9), thrust washer (20), key (11), flanged bearing (18), and seal (17) from shaft (30).

(2) Remove capscrews (43), lockwashers (42) and cover (41).

(3) Remove capscrews (45), lockwashers (46), gasket (38), and cover (39).

(4) Loosen jam nut (9) and setscrew (8).

(5) Remove the worm gear (49) and center plate (31) from shaft (30).

(6) Remove the capscrews (1), closed end plug (3), and gasket (4).

(7) Remove the capscrews (32), end cap (34), and gasket (35).

(8) Remove the shaft (26), spacers (7 and 27), and worm (28) from the gear box.

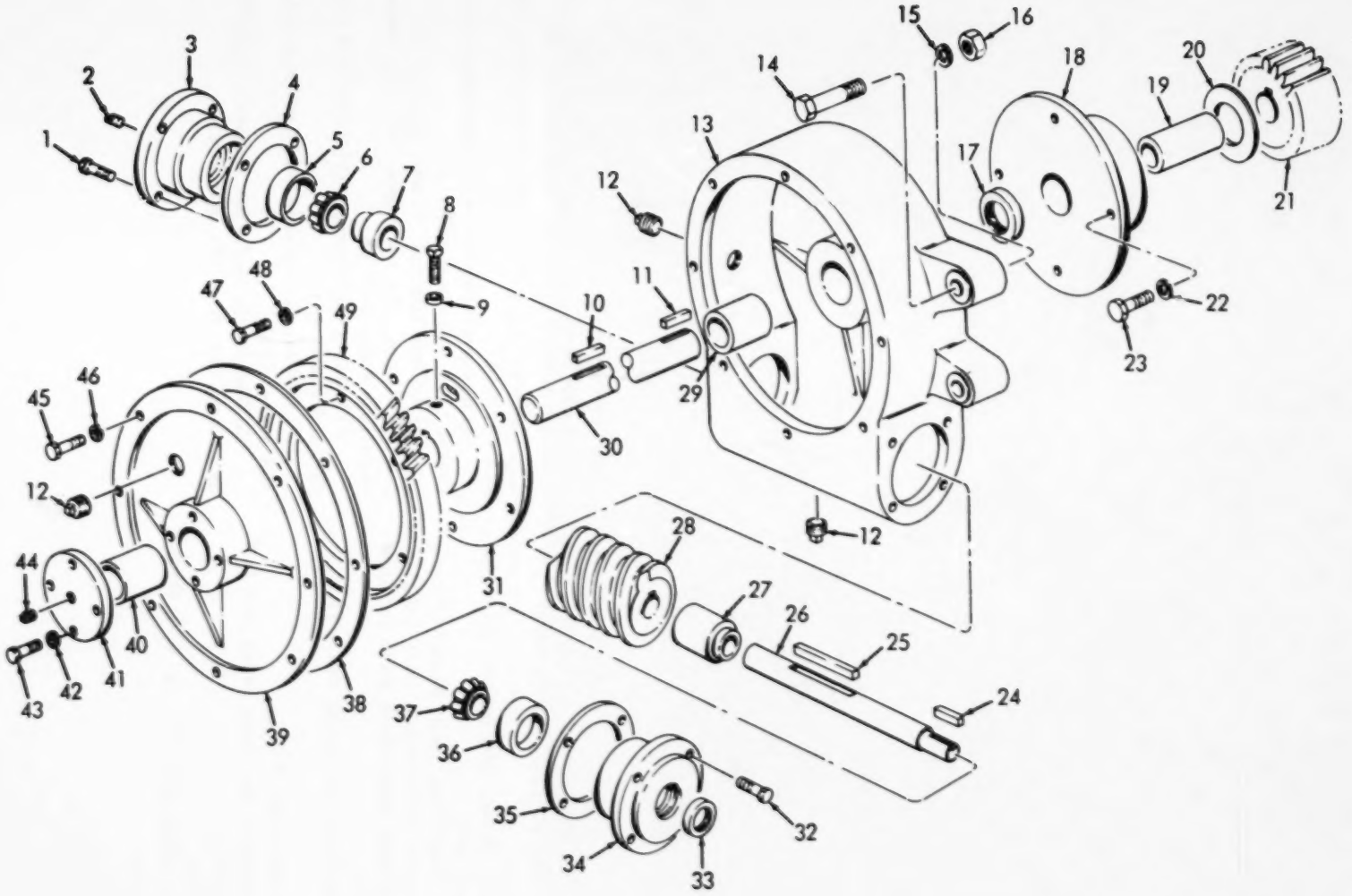


Figure 4-9. Boom swing box assembly, exploded view.

Key to figure 4-9:

1 Capscrew
2 Lubrication fitting
3 Closed end plug
4 Gasket
5 Bearing cup
6 Bearing
7 Spacer
8 Setscrew
9 Jam nut
10 Key
11 Key
12 Pipe plug
13 Gear case
14 Capscrew
15 Lockwasher
16 Nut
17 Seal
18 Flanged bearing
19 Bushing
20 Thrust washer
21 Pinion gear
22 Lockwasher
23 Capscrew
24 Key
25 Key
26 Shaft
27 Spacer
28 Worm
29 Bushing
30 Shaft
31 Center plate
32 Capscrew
33 Seal
34 End cap
35 Gasket
36 Bearing cup
37 Bearing
38 Gasket
39 Cover
40 Bushing
41 Cover
42 Lockwasher
43 Capscrew
44 Pipe plug
45 Capscrew
46 Lockwasher
47 Screw
48 Lockwasher
49 Worm gear

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved solvent. Dry thoroughly.

(2) Inspect the shafts (26 and 30) for scoring and wear.

(3) Inspect the bushings (19, 29, and 40) for scoring and excessive wear. If play on drive pinion shaft (30) exceeds 0.015-0.025 inch, replace the bushings.

(4) Inspect the bronze worm gear teeth for excessive wear. Check the wear by meshing the steel worm (28) with worm gear. If end play of worm shaft exceeds 1 / 32 inch, replace the worm gear on the center plate (31) by removing the capscrews (47) and lockwashers (48). When replacing the worm gear, make sure that the capscrews are tightened securely.

(5) Inspect the steel worm for scoring. Replace as required.

(6) Inspect the tapered roller bearings (6 and 37) for worn rollers and rough spots while rotating the bearings. Inspect the bearing cups (5 and 36) for rough spots. Replace as required.

(7) Inspect the keys (10, 11, 24, and 25) for wear. If any are loose fitting in respective keyways, replace.

(8) Inspect the thrust washer (20) for scoring and wear. Minimum thickness is 0.225 inch. Replace as required.

(9) Remove the seals (17 and 33).

d. Assembly. Assemble the gear case assembly in the reverse order of disassembly. Replace seals (17 and 33) and gaskets (4 and 35) with new units.

e. Installation. Install the gear box assembly (TM 5-3810-233-12).

4-15. Rotary Seal and Collector Ring Assemblies

a. Removal.

(1) Remove the crane superstructure (TM 5-3810-233-12).

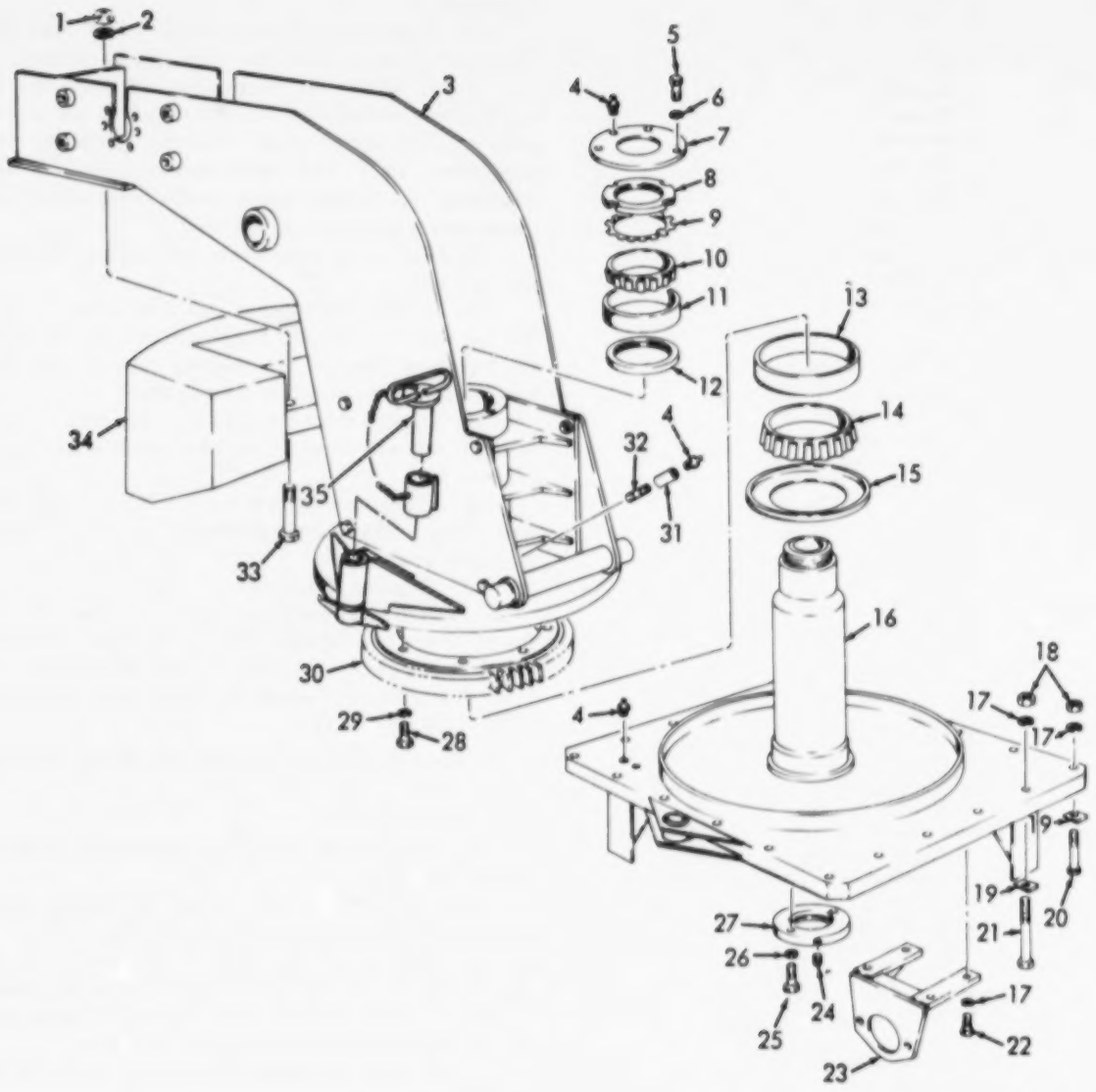
(2) Disconnect the nine hydraulic lines connected to base of rotary seal unit (fig. 4-8).

(3) Disconnect the hoist drain connection at top of unit, two boom hoist cylinder lines, two boom extension cylinder lines, two clamshell lines, and two hoist motor lines from seal housing.

(4) Loosen the setscrews (24, fig. 4-10) in the locking collar (27).

(5) Remove the nuts (11, fig. 4-11), lockwashers (12), capscrews (15), washers (14), and spacers (13).

(6) Remove the seal and collector ring assemblies.



1 Nut
2 Lockwasher
3 Upper turret assembly
4 Lubrication fitting
5 Capscrew
6 Lockwasher
7 Dirt shield
8 Locknut
9 Lockwasher
10 Bearing
11 Bearing race
12 Seal
13 Bearing race
14 Bearing
15 Pan
16 Bed & sleeve assembly
17 Lockwasher
18 Nut
19 Beveled washer
20 Capscrew
21 Capscrew
22 Capscrew
23 Motor support bracket
24 Setscrew
25 Capscrew
26 Lockwasher
27 Lock collar
28 Capscrew
29 Lockwasher
30 Ring gear
31 Pipe coupling
32 Pipe nipple
33 Capscrew
34 Counterweight housing
35 Locking pin

Figure 4-10. Upper turret assembly, exploded view.

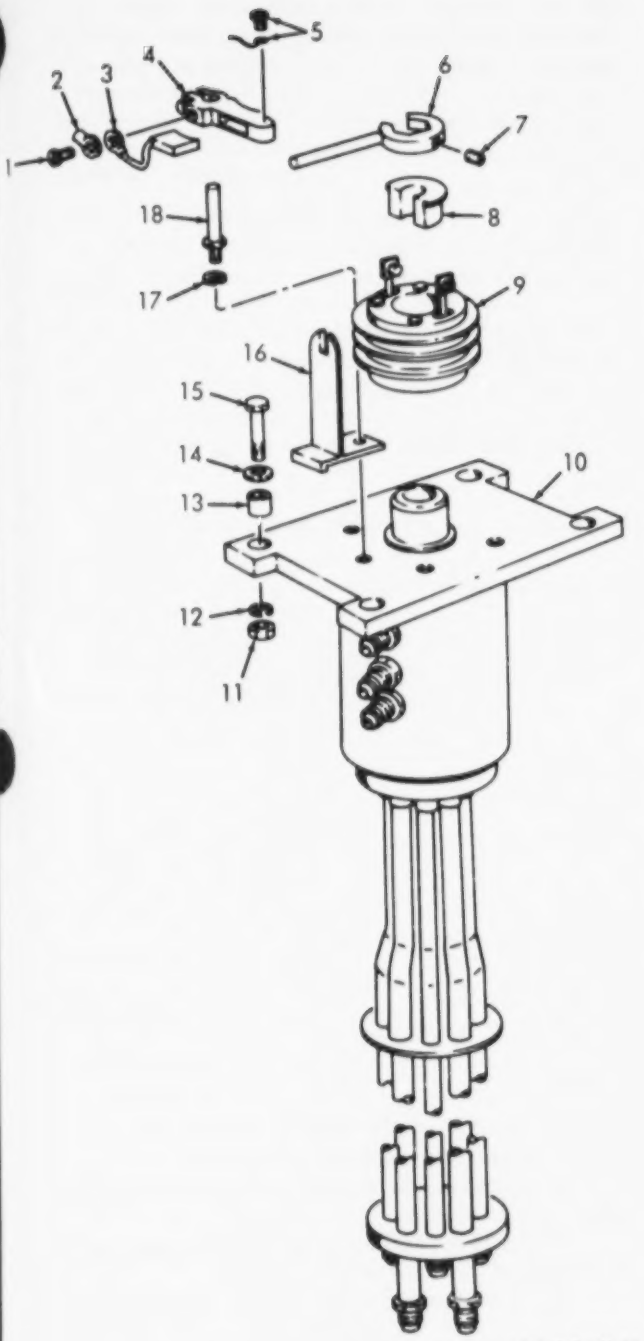


Figure 4-11. Rotary seal and collector ring assemblies, exploded view.

Key to figure 4-11:

1 Screw
2 Terminal lug
3 Brush w / lead
4 Brush holder
5 Screw and spring
6 Swivel lock
7 Setscrew
8 Split sleeve
9 Collector ring assembly
10 Rotary seal assembly
11 Nut
12 Lockwasher
13 Spacer
14 Flatwasher
15 Screw
16 Guide bracket
17 Lockwasher
18 Brush holder stud

b. Disassembly.

(1) Loosen the setscrew (7) and remove the swivel lock (6).

(2) Remove the screws (1), terminals (2), brush holders (4), with brushes (3), tension springs, and screws (5) from the stud (18).

NOTE

Further disassembly will not be required unless damage to other components is observed during inspection.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved solvent. Dry thoroughly.

(2) Inspect all fittings on the rotary seal for damaged threads. Replace the unit if necessary.

NOTE

The rotary seal unit is a high-pressure, precision-machined, hydraulic rotary coupling unit which requires a minimum of service.

(3) Inspect the collector ring brushes for wear. Replace if worn to a point where brush holder spring tension does not hold them firmly against the collector rings. Replace springs (5) if weak.

(4) Polish collector rings (9) with a fine grade of abrasive paper (No. 000 or equivalent).

d. Assembly. Assemble the unit in the reverse order of disassembly.

e. Installation. Install the unit in the superstructure in the reverse order of removal.

4-16. Upper Turret Assembly

a. Removal.

NOTE

Removal of the hook block, main boom, and hoist drum and drive is not mandatory but is desirable because of lessened weight and greater ease in handling. Refer to paragraph 4-2.

(1) Remove the rotary seal and collector ring assembly (para 4-15).

(2) Remove the crane sub-base and upper turret (TM 5-3810-233-12).

(3) Remove the boom swing drive assembly (para 4-14).

(4) Remove the capscrews (5, fig. 4-10), lockwashers (6), and dirt shield (7). Remove the locknut (8) and lockwasher (9).

(5) Attach a sling to the upper turret assembly

(3) and with suitable lifting device, remove the assembly from the bed and sleeve assembly (16).

b. Disassembly.

(1) Remove the tapered roller bearings (10 and 14), and races (11 and 13).

(2) Remove the seal (12) and pan (15).

(3) Remove the nuts (1), lockwashers (2), capscrews (33), and counterweight housing (34).

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved solvent. Dry thoroughly.

(2) Remove all rust and scaling paint with a stiff wire brush and abrasive cloth. *Paint all bare metal surfaces before assembling the unit.*

(3) Inspect the roller bearings for wear and rough spots on the rollers. Inspect the bearing races (11 and 13) for rough spots. Replace bearings and races as required.

(4) Inspect the ring gear (30) for worn or damaged teeth. Replace, if necessary, by removing capscrews (28) and lockwashers (29).

NOTE

Removal of the motor support bracket (23) and lock collar (27) with attaching hardware is not required unless the components are damaged. The attaching hardware (items 17, 18, 19, and 20) are removed when the crane superstructure is removed from the carrier.

(5) Replace the lubrication fittings (4) when assembling the unit.

(6) Install a new seal (12) when replacing the upper race and bearing.

d. Assembly. Assemble the upper turret assembly in the reverse order of disassembly.

e. Installation. Install the turret assembly in the reverse order of removal.

4-17. Anchor Bracket

a. General. The anchor brackets are provided to stabilize the upper turret and boom assembly when the unit is in transit. When crane is in normal operation, the anchor brackets are swung up and attached to the boom, with anchor pins. Elevate the main boom 10 degrees in order that the ends of the anchor brackets will clear the boom hoist cylinders.

NOTE

A support plate is provided for long transit shipment and when extra stength of the anchor bracket is desired.

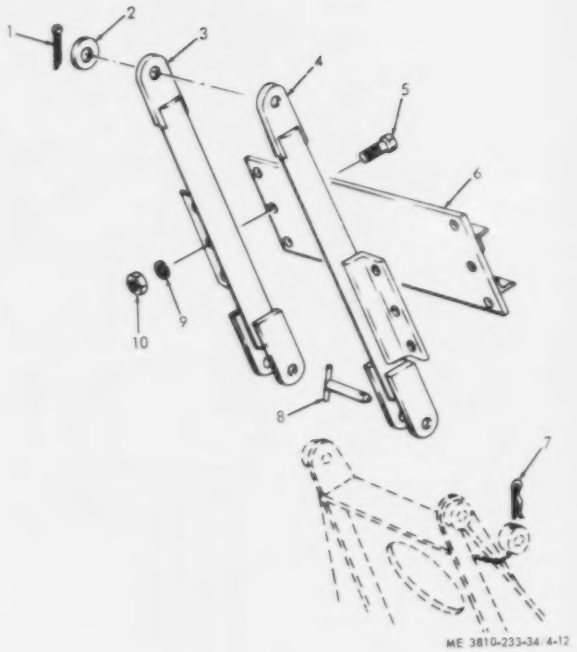
b. Removal.

(1) If support plate (6, fig. 4-12) is mounted on the arms, remove six screws (5), nuts (10), and lockwashers (9) to remove the plate.

(2) Remove retaining pin (7) and anchor pin (8) from swinging end of the arm.

(3) Remove cotter pin (1) and washer (2) from lug on side of the boom and slide right hand anchor bracket off.

(4) Remove the left hand arm in the same manner.



1 Cotter pin
2 Washer
3 Arm, rh
4 Arm, lh
5 Screw
6 Support plate
7 Retaining pin
8 Anchor pin
9 Lockwasher
10 Hex nut

Figure 4-12. Anchor bracket, exploded view.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved solvent and dry thoroughly.

(2) Inspect parts for broken welds, bent arms, or damaged pivot or anchor holes.

(3) Weld broken welds. Straighten bent arms.

NOTE

Straightening of badly bent arms may crystalize the arm, and cause a point of weakness in the material. Replace a badly bent arm.

(4) Remove any rust present and repaint.

(5) Replace any part that is badly worn or damaged.

d. Installation. Install the anchor bracket in reverse order of removal.

Section V. CRANE HYDRAULIC SYSTEM

4-18. General

The crane hydraulic system consists of the hydraulic pump, drive motors (previously covered), actuating cylinders (excluding hoist cylinders previously covered), reservoir, filters, valves, lines, and fittings (fig. 1-6). Each item will be covered from a removal, disassembly, repair, and installation point-of-view.

4-19. Crane Hydraulic Pump

a. General. The crane hydraulic pump is a high-volume, high-pressure unit mounted on the carrier frame at the front of the engine, and driven by the engine crankshaft through an adapter and roller chain coupling. The pump supplies the fluid power required for all crane operations, and the power for the power-assist front steering.

b. Removal. Remove the hydraulic pump (TM 5-3810-233-12).

c. Disassembly.

(1) Remove the bracket (28, fig. 4-13) and shaft key (34).

(2) Clamp the pump body (29) in a vise with protective jaw covering.

(3) Remove the four cover screws (1).

(4) Mark the cover and inlet housing to insure correct port positioning during assembly.

(5) Remove the cover (2) and packing (7).

(6) Pull out the end cartridge.

(7) Remove four screws (16).

(8) Remove inlet housing (17) and packing (43).

(9) Turn shaft (35) to free large cartridge and remove cartridge from body (29).

(10) Remove large lockring (37) and pull out shaft (35) and bearing (36).

(11) Drive out shaft seal (31) and wiper (30) from the body (29).

(12) Remove the preformed packing (O-rings) and back-up rings from the pressure plate (44).

(13) Remove the two fillister-head screws (18) and lift off the wear plate (20).

CAUTION

Note carefully the position of the ring, rotor, and vanes to insure proper positioning when reassembling.

(14) Repeat the above procedure in disassembling the wear plate (13) and pressure plate (8).

(15) Separate the rings, rotors, vanes, locating pins, and pressure plates.

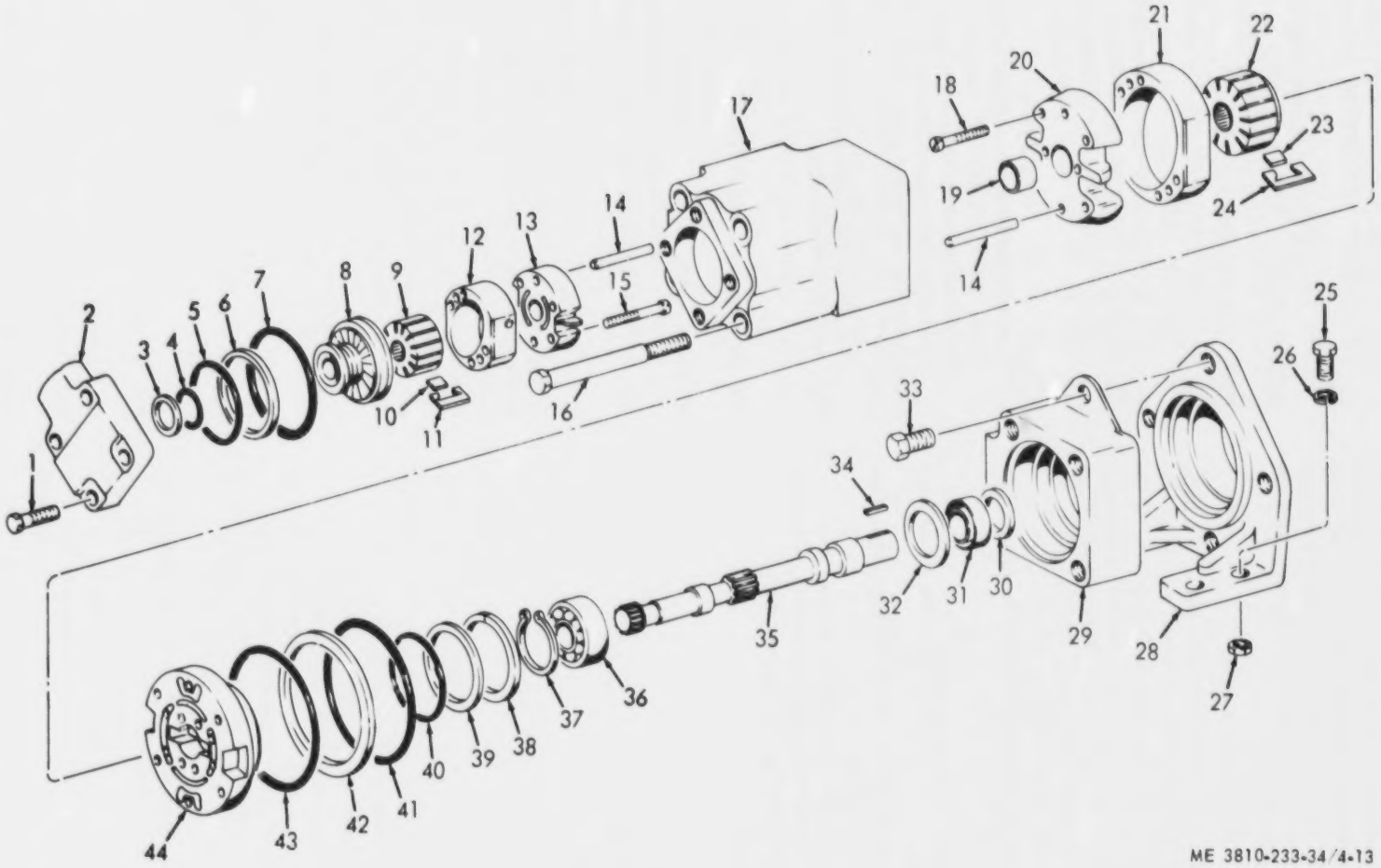


Figure 4-13. Hydraulic pump, double vane, exploded view.

Key to figure 4-13:

1 Screw
2 Outlet cover
3 Back-up ring
4 Packing
5 Packing
6 Back-up ring
7 Packing
8 Pressure plate
9 Rotor
10 Insert
11 Vane
12 Ring
13 Wear plate
14 Locating pin
15 Screw
16 Screw
17 Inlet housing
18 Screw
19 Bushing
20 Wear plate
21 Ring
22 Rotor
23 Insert
24 Vane
25 Screw
26 Lockwasher
27 Nut
28 Bracket
29 Body
30 Wiper
31 Seal
32 Washer
33 Screw
34 Key
35 Shaft
36 Bearing
37 Snap ring
38 Lockring
39 Back-up ring
40 Packing
41 Packing
42 Back-up ring
43 Packing
44 Pressure plate

d. Cleaning, Inspection, and Repair.

(1) Wash all metal parts in clean, dry cleaning solvent. Dry with filtered compressed air.

(2) Place all parts on a clean surface for inspection.

(3) Check the wearing surfaces of the cartridge parts for scoring or excessive wear. Remove light score marks by lapping. Replace heavily scored or badly worn parts.

NOTE

Cartridge kits are available assembled and pre-tested. If the old cartridges are worn extensively, kit replacement will probably be advantageous.

(4) Inspect vanes (11 and 24) and inserts (10 and 23) for burrs, wear, and excessive play in rotor slots (9 and 22). Replace rotor if slots are worn.

(5) Rotate shaft bearing (36) while applying pressure to check for wear, looseness and / or rough races. Replace as required after removing retainer ring (37).

CAUTION

When replacing bearing, make sure that the inner race of bearing is supported in the arbor press.

(6) Inspect seal and bushing mating surfaces on shaft for scoring or wear. Remove light scoring by lapping; otherwise, replace shaft (35).

e. Assembly.

(1) Coat all pump parts with clean hydraulic fluid to facilitate reassembly. Apply small amounts of petroleum jelly to all preformed packing to hold in place during assembly.

(2) Place the rotor (22) on the pressure plate (44) with the arrows on the rotor pointed in the correct direction of rotation.

NOTE

The correct direction of rotation is left hand (counterclockwise) when viewed from the shaft end of the pump.

(3) Insert the vane (23 and 24) in the rotor with the radius edges of the vanes facing towards the ring (21) when installed.

(4) Install the two locating pins (14) in the pressure plate (44).

(5) Place the ring (21) on the pressure plate (44) with the ring arrow pointing in the correct direction of rotation.

(6) Apply a small amount of good grade of sealant to the threads of screws (18). Install the wear plates (20) on the ring (21). Insert the screws in the wear plate. Engage in pressure plate and tighten securely.

(7) Install new shaft wiper (30) and seal (31) in body (29). Use seal installing tool (fig. 2-1) to avoid damaging seal.

(8) Clamp body (29) in a vise and install washer (32) against seal.

(9) Press shaft (35) into bearing (36) in an arbor press, supporting inner bearing race. Install retainer ring (37).

(10) Tape end of shaft and lubricate seal lip with grease or petroleum jelly.

(11) Tap shaft and bearing into body and install lockring (38).

(12) Install preformed packing (40) on pressure plate hub (44). Install back-up ring (39).

(13) Install packing (41) and back-up ring (42) on pressure plate hub (44). Lay the body packing (43) in place and install the cartridge assembly in the body so that one of the flats on ring (21) will aline with the inlet port when the inlet housing (17) is installed.

(14) Place the inlet housing (17) over the cartridge so that the locating pins are properly engaged, and the inlet is in the correct position with respect to the body outlet.

(15) Install the four bolts (16) and tighten to a torque of 70 ft-lbs.

(16) Assemble the cover end cartridge by placing the rotor (9) on the pressure plate (8) with the arrow on the rotor pointed in the correct direction of rotation. Insert the vanes (10 and 11) in the rotor with the radius edges of the vanes facing towards the ring (12) when installed. Install the two locating pins (14) in the pressure plate (8). Place the ring (12) on the pressure plate with the ring arrow pointing in the correct direction of rotation. Apply a small amount of good grade of sealant to the threads of screws (15). Install the wear plate (13) on the ring (12). Insert the screws in the wear plate. Engage in pressure plate (8) and tighten securely.

(17) Install the cover end cartridge, making sure that the locating pins engage in the body. Place the back-up ring (6) and packing (5) on the pressure plate hub (8).

(18) Place the packing (7) in its groove in the cover (2) and replace the cover, securing with four screws (1). Tighten to a torque of 45 ft-lbs.

f. Installation. Install the pump (TM 5-3810-233-12).

4-20. Crane Control Valves (Hydraulic)

a. General. The two banks of hydraulic control valves are similar in function, but differ in design in that the multi-unit valves are five and six section assemblies with the relief valve pressures set at 2500 and 2000 psi, respectively. However, repair and maintenance instructions are similar in either case.

b. Removal.

(1) Disconnect hydraulic lines to the valve assemblies.

(2) Remove the attaching hardware and valve assemblies (fig. 4-14).

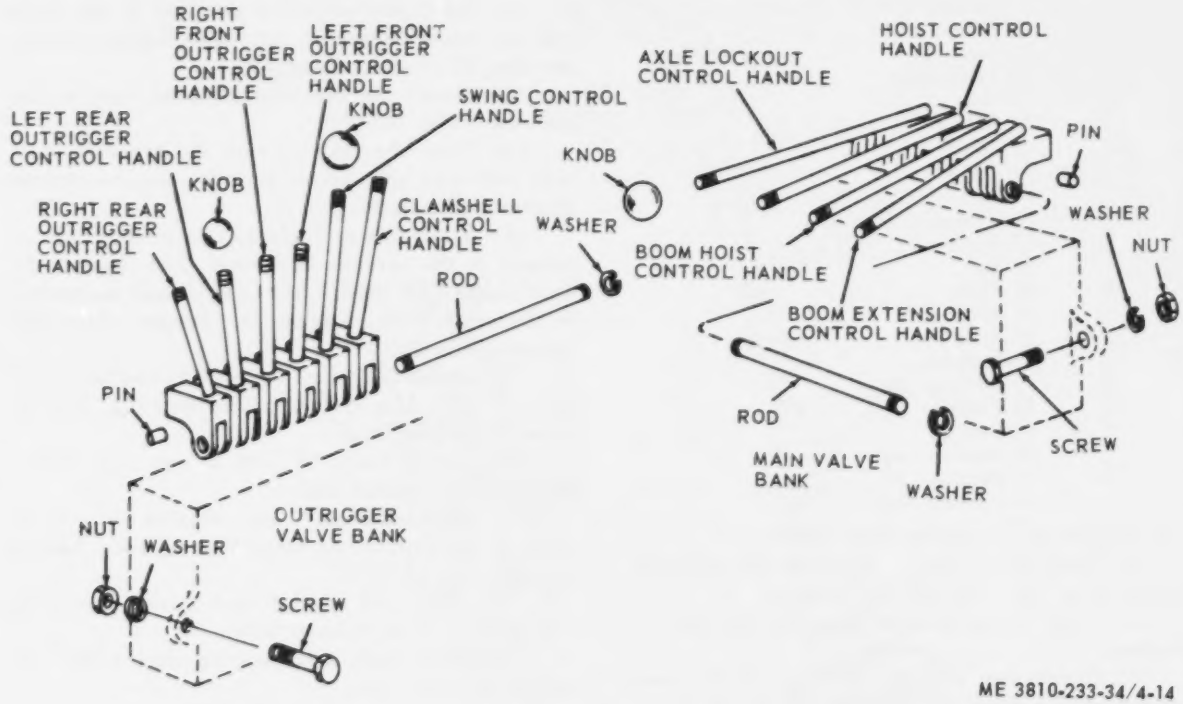


Figure 4-14. Hydraulic valve assembly, removal and installation.

c. Disassembly.

(1) Remove the nuts (12, fig. 4-15) and studs (13).

(2) Separate the sections.

(a) Inlet section (1).

(b) Center sections (6).

(c) Outlet section (11).

CAUTION

Mark the motor sections (B-type spool) for hoist motor (center section of five-unit assembly) and swing motor (next to outlet section of six-unit assembly). These sections must be placed in their correct positions during assembly since porting design differs from the standard D-type section.

(3) Remove the screws (26), retainer (25), and sleeve (24).

(4) Slide the spool (21) out of the section and remove the preformed packing (23 and 27). Do not remove the centering spring (22) and "C" washers (28) unless it is necessary to replace them.

CAUTION

Keep each spool with its respective section. They are not serviced separately and are not to be interchanged.

(5) Remove the check valve plug (17), from the outlet section (11). Remove the packing (18), back-up ring (16), spring (15), and ball (14).

(6) Remove the plug (5), packing (4), spring (3), and valve (2) from the inlet section (1).

(7) Remove the retainer (8) and packing (7).

NOTE

During disassembly of valve assembly, seals (9, 19, and 20) and retainer (10) should be removed. Discard all seals and preformed packing removed. Replace with new seals and packing contained in seal kit when assembling valve assembly.

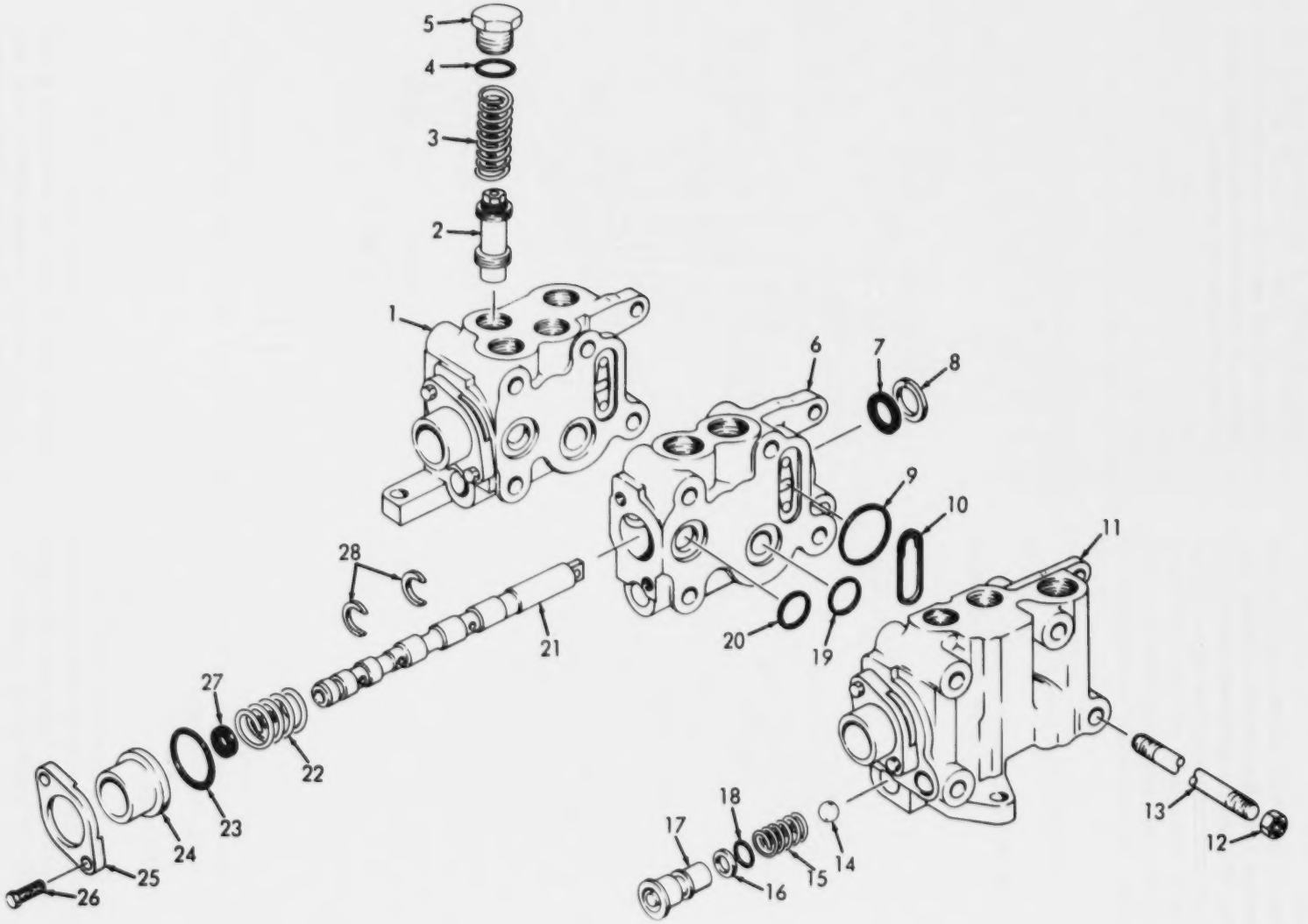


Figure 4-15. Multi-unit valve, exploded view.

Key to figure 4-15:

1 Inlet section
2 Valve
3 Spring
4 Preformed packing
5 Plug
6 Center sections (see text)
7 Preformed packing
8 Retainer
9 Seal
10 Retainer
11 Outlet section
12 Nut (4)
13 Stud (4)
14 Ball
15 Spring
16 Back-up ring
17 Plug
18 Preformed packing
19 Seal
20 Seal
21 Spool
22 Centering spring
23 Preformed packing
24 Sleeve
25 Retainer
26 Screw
27 Preformed packing
28 "C" washer (4 per spool)

d. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved solvent. Dry thoroughly with filtered compressed air. Place on clean surface for inspection.

(2) Check spools carefully. Remove light scoring with lapping stone or fine crocus cloth. Otherwise, replace spool with new mating section.

(3) Remove any foreign material or burred edges from mating surfaces of valve sections.

e. Assembly.

(1) Coat all parts with clean hydraulic fluid. Coat all seals and packing with petroleum jelly.

(2) Assemble the sections on a surface plate or other plane surface to provide accurate alinement.

(3) Assemble sections and components parts in the reverse order of disassembly.

CAUTION

Do not interchange end sections of the two valve assemblies.

(4) Coat the stud threads with a good grade of sealant. Tighten the nuts to a torque of 15 ft-lbs.

f. Installation. Install the valves in the crane (fig. 4-14).

4-21. Hydraulic Rear Axle Stabilizing Cylinder

a. Removal. Remove the hydraulic cylinder(s) (TM 5-3810-233-12).

b. Disassembly.

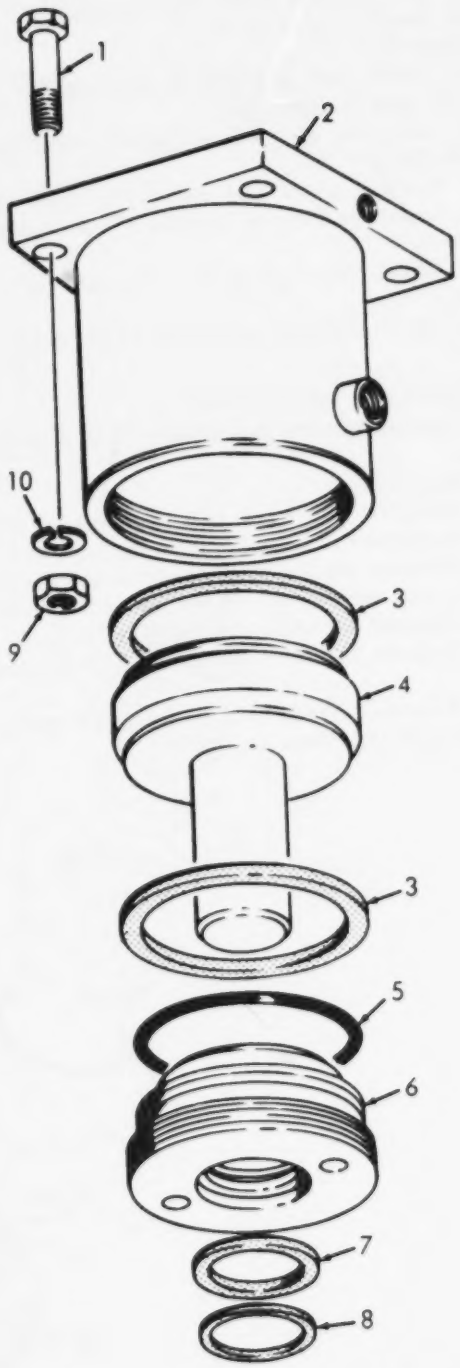
(1) Remove the head (6, fig. 4-16) from the body (2).

(2) Withdraw the piston and rod (4).

(3) Remove all packing from piston (4) and head (6). Discard old packing.

Key to figure 4-16:

1 Screw
2 Body
3 Preformed packing
4 Piston and rod
5 Preformed packing
6 Head
7 Preformed packing
8 Wiper
9 Hex nut
10 Lockwasher



ME 3810-233-34/4-16

Figure 4-16. Hydraulic cylinder, stabilizing, exploded view.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly.

(2) Inspect the bore of the cylinder (2) and the piston rod (4) for scoring. Remove fine scoring marks with a lapping stone or fine crocus cloth. Replace deeply scored parts.

d. Assembly.

(1) Install new preformed packing (3) on piston (4) and in head (6).

(2) Lubricate all surfaces lightly with clean hydraulic fluid.

(3) Replace piston and rod (4) in body (2).

(4) Install preformed packing (7) and wiper (8) in head (6).

(5) Install head in body (2) and tighten securely.

e. Installation. Install cylinder (TM 5-3810-233-12).

4-22. Outrigger Arm Cylinder

a. Removal. Remove the cylinder (TM 5-3810-233-12).

b. Disassembly.

(1) Unscrew the head (19, fig. 4-17) and remove the piston rod assembly from the body (10).

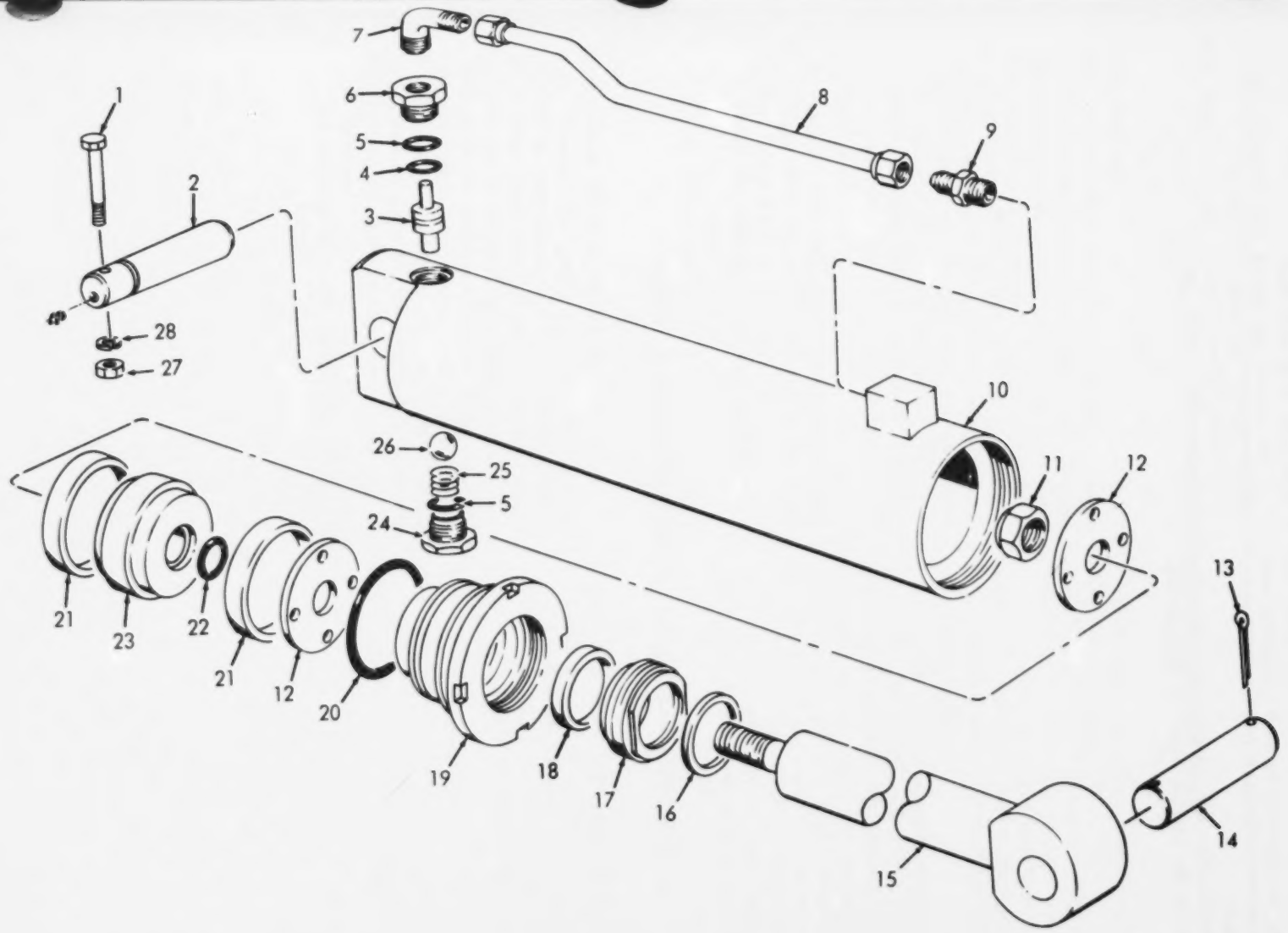
(2) Remove the locknut (11) from the piston rod (15), and remove all piston assembly components. Discard all seals and packing.

(3) Remove the tube assembly (8) from the body.

(4) Remove the plug (24), packing (5), spring (25), and ball (26) from the body.

Key to figure 4-17:

1 Bolt
2 Pin
3 Pilot piston
4 Packing
5 Packing
6 Reducer
7 Elbow
8 Tube assy.
9 Connector
10 Body
11 Locknut
12 Plate
13 Cotter pin
14 Pin
15 Rod
16 Rod wiper
17 Gland
18 Packing
19 Head
20 Seal
21 Packing
22 Packing
23 Piston
24 Plug
25 Spring
26 Steel ball
27 Nut
28 Lockwasher



ME 3810-233-34/4-17

Figure 4-17. Hydraulic cylinder, outrigger, exploded view.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly.

(2) Inspect the body, rod, and piston for scoring. Remove fine scoring with a lapping stone or fine crocus cloth. Replace deeply scored parts.

d. Assembly.

(1) Reassemble the piston rod assembly components in the reverse order of disassembly.

(2) Replace all packing and seals with new parts.

(3) Lubricate the piston rod assembly lightly with clean hydraulic fluid.

(4) Install the piston rod assembly in the body. Tighten the head (19) securely.

e. Installation. Install the outrigger arm cylinder (TM 5-3810-233-12).

CHAPTER 5

REPAIR OF REVERS-O-MATIC DRIVE

Section I. REVERS-O-MATIC DRIVE ASSEMBLY

5-1. General

The revers-o-matic drive consists of a torque converter, a shuttle-type transmission with forward and reverse clutch assemblies operated by a lever-type control, and coupled to a four-speed transmission assembly. The transmission assembly is coupled to a transfer gear assembly, which in turn, is connected to the driving axles via connecting shafts equipped with universal joints. The heat exchanger is omitted from the unit, with the engine oil cooler performing a dual function (para 3-30).

5-2. Removal

a. Remove the crane superstructure (para 4-2).

b. Disconnect all control linkage to the transmission (para 2-8).

c. Drain the fluid from the transmission.

d. Remove the drive shaft assembly to the transfer case (para 2-9).

e. Remove the transmission housing assembly mounting bolts from the chassis frame (para 2-8).

f. Remove the torque converter housing bolts from the engine flywheel housing, and remove the transmission assembly from the chassis.

5-3. Disassembly

a. General. The transmission assembly is composed of several subassemblies; the torque converter and housing assembly; the shuttle transmission assembly; the 4-speed transmission assembly, the primary pump, manifold and filter assembly, and the control valve assembly.

b. Disassembly. Each subassembly is covered in a separate paragraph, with each paragraph sequenced in a logical order of removal.

Section II. REVERS-O-MATIC DRIVE COMPONENTS

5-4. Clutch Control and Linkage

a. General. The clutch is shifted from neutral position to either forward or reverse travel position by a single lever control, and the desired transmission gear is selected by a single lever (TM 5-3810-233-12). A single control cable assembly connects the clutch control lever to the shuttle transmission, and two similar cable control assemblies connects the transmission shift lever to the 4-speed transmission.

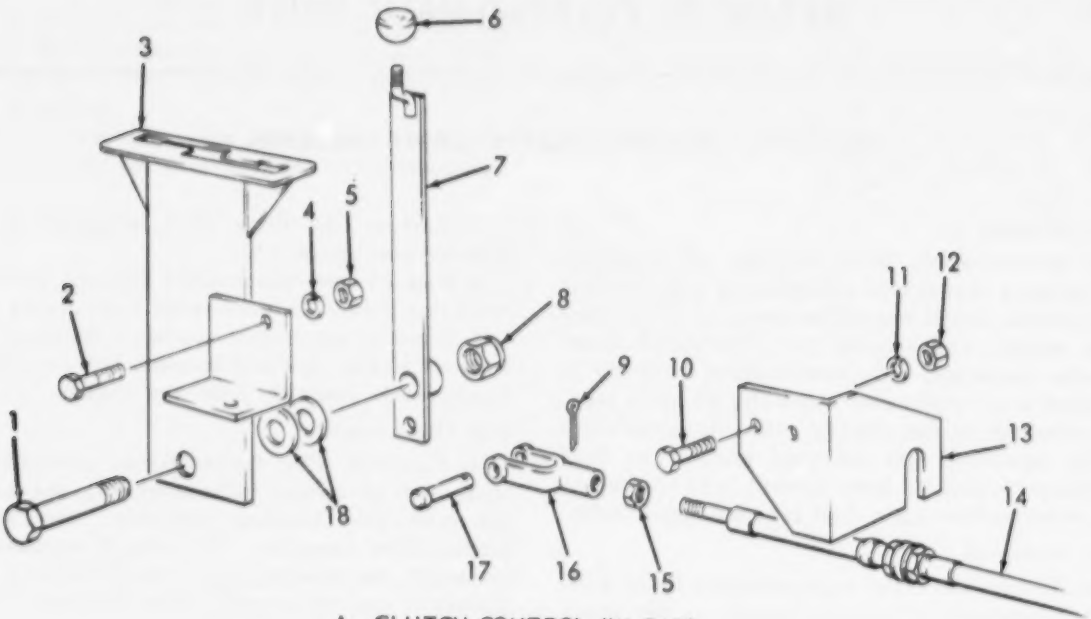
b. Removal.

(1) Remove nut (28, fig. 5-1), lockwasher (29), ball joint (19), and locknut (15) from transmission end of clutch control cable.

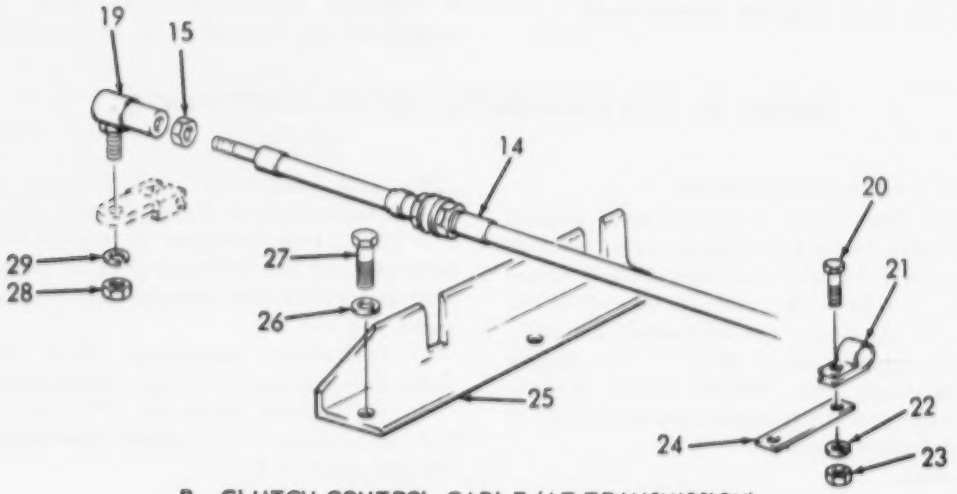
(2) Loosen locknuts on control cable (14); remove nut (23), lockwasher (22), capscrew (20), and clamp (21) from transfer case. Remove control cable (14).

(3) Remove capscrews (27), lockwashers (26), and bracket (25) from transmission housing.

(4) Remove cotter pin (9), pin (17), clevis (16) and locknut (15). Loosen locknuts and remove control cable (14).



A. CLUTCH CONTROL (IN CAB)



B. CLUTCH CONTROL CABLE (AT TRANSMISSION)

ME 3810-233-34/5-1

1 Screw
2 Screw (2)
3 Clutch ratchet
4 Lockwasher (2)
5 Nut (2)
6 Knob
7 Lever
8 Locknut
9 Cotter pin
10 Screw (2)
11 Lockwasher (2)
12 Nut (2)
13 Bracket
14 Flex-cable
15 Nut (2)
16 Clevis
17 Clevis pin
18 Flatwasher (2)
19 Ball joint
20 Screw
21 Clamp
22 Lockwasher
23 Nut
24 Strap
25 Bracket
26 Lockwasher (2)
27 Screw (2)
28 Nut
29 Lockwasher

Figure 5-1. Clutch control and linkage, exploded view.

c. Disassembly.

(1) Repair of the control cable is not recommended. Replace the control cable if worn or binding in movement.

(2) Removal of the clutch ratchet (3), lever (7), bracket (13), and associated hardware will not be required unless excessive play is evidenced in the overall control operation.

d. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly.

(2) Inspect all hardware and associated parts for wear, scored threads, or other damage. Replace parts as required.

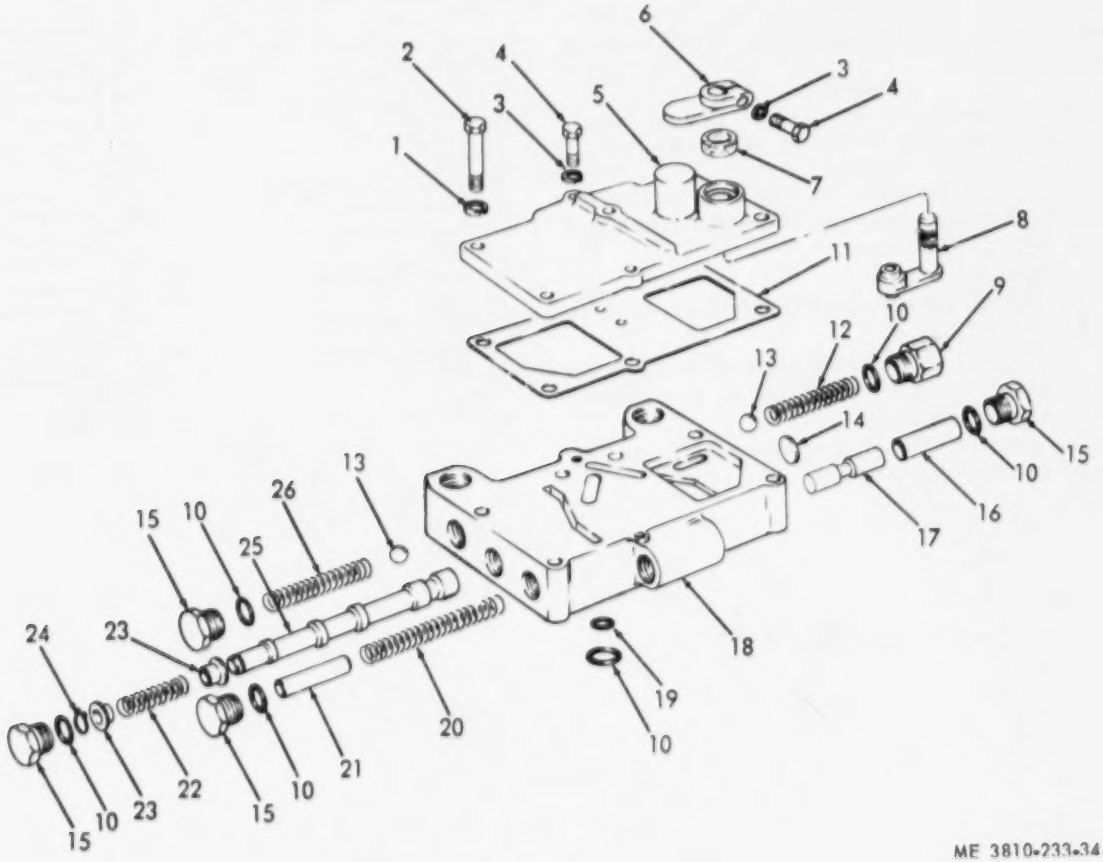
e. Assembly and Installation.

(1) Assemble and install the clutch control in the reverse order of disassembly and removal.

(2) Adjust the travel of the control cable to ⅜-inch in either direction by varying the positions of the ball joint (19) and clevis (16) on the control cable.

5-5. Transmission Control Valve

a. Removal. Remove the capscrews (2 and 4, fig. 5-2), lockwashers (1 and 3), and remove the control valve assembly from the shuttle transmission housing.



ME 3810-233-34/5-2

1 Lockwasher (4)
2 Capscrew (4)
3 Lockwasher (3)
4 Capscrew (3)
5 Cover
6 Arm
7 Seal
8 Arm
9 Cap
10 Preformed packing (9)
11 Gasket
12 Spring
13 Ball (2)
14 Plug
15 Cap (4)
16 Valve, female
17 Valve, male
18 Body
19 Preformed packing (4)
20 Spring
21 Pin
22 Spring
23 Spacer (2)
24 Retainer ring
25 Valve
26 Spring

Figure 5-2. Transmission control valve, exploded view.

b. Disassembly.

(1) Remove the cover (5, fig. 5-2) and gasket (11) from the valve body (18).

(2) Remove the caps (9 and 15), packing (10), retainer ring (24), spacers (23), springs (12, 20, 22, and 26), balls (13, and valves (16, 17, and 25) from the body (18).

(3) Remove the capscrew (4), lockwasher (3), arm (6), and arm (8) from the cover (5).

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly. Discard all old gaskets and preformed packing.

(2) Clean all orifices and passageways in the valve body thoroughly.

(3) Inspect all parts for wear and scoring. Remove light scoring marks from valves with a lapping stone. Replace any deeply scored or worn components.

NOTE

The component parts of the valve assembly are matched parts. Do not replace individually, but replace the entire assembly.

(4) Check the valve springs for compression strength. If easily compressed between thumb and finger, replace the finger.

d. Assembly.

(1) Lubricate all springs and valves with clean hydraulic fluid.

(2) Assemble the control valve assembly in the reverse order of disassembly. Use all new gaskets and preformed packing.

e. Installation. Install the control valve on the shuttle transmission housing.

5-6. Four-Speed Transmission

a. Removal.

(1) Remove the capscrews (44 and 46, fig. 5-3), lockwashers (43 and 48) that attach the transmission case (45) to the shuttle transmission case.

(2) Remove the transmission assembly and gasket (49).

Key to figure 5-3:

1 Shift arm
2 Retainer pin
3 Shift side cap
4 Gasket
5 Ball
6 Spring
7 Shift sector shaft
8 Shift sector
9 Inhibitor block
10 Shifter fork
11 Wire
12 Capscrew
13 Second gear
14 Low gear
15 Low gear bearing roller
16 Thrust washer
17 Output bearing
18 Third gear
19 Brake mount stud
20 Gasket
21 Rear bearing retainer
22 Shakeproof washer
23 Nut
24 Seal
25 Washer
26 Capscrew
27 Rear bearing
28 Countershaft
29 Bearing
30 Second gear
31 Shifting collar
32 Hub
33 Bearing sleeve
34 Third gear
35 Drive gear
36 Front bearing
37 Capscrew
38 Washer
39 Seal
40 Retainer pin
41 Shifter fork
42 Main shaft
43 Lockwasher
44 Capscrew
45 Transmission case
46 Capscrew
47 Drain plug
48 Lockwasher
49 Gasket
50 Shim

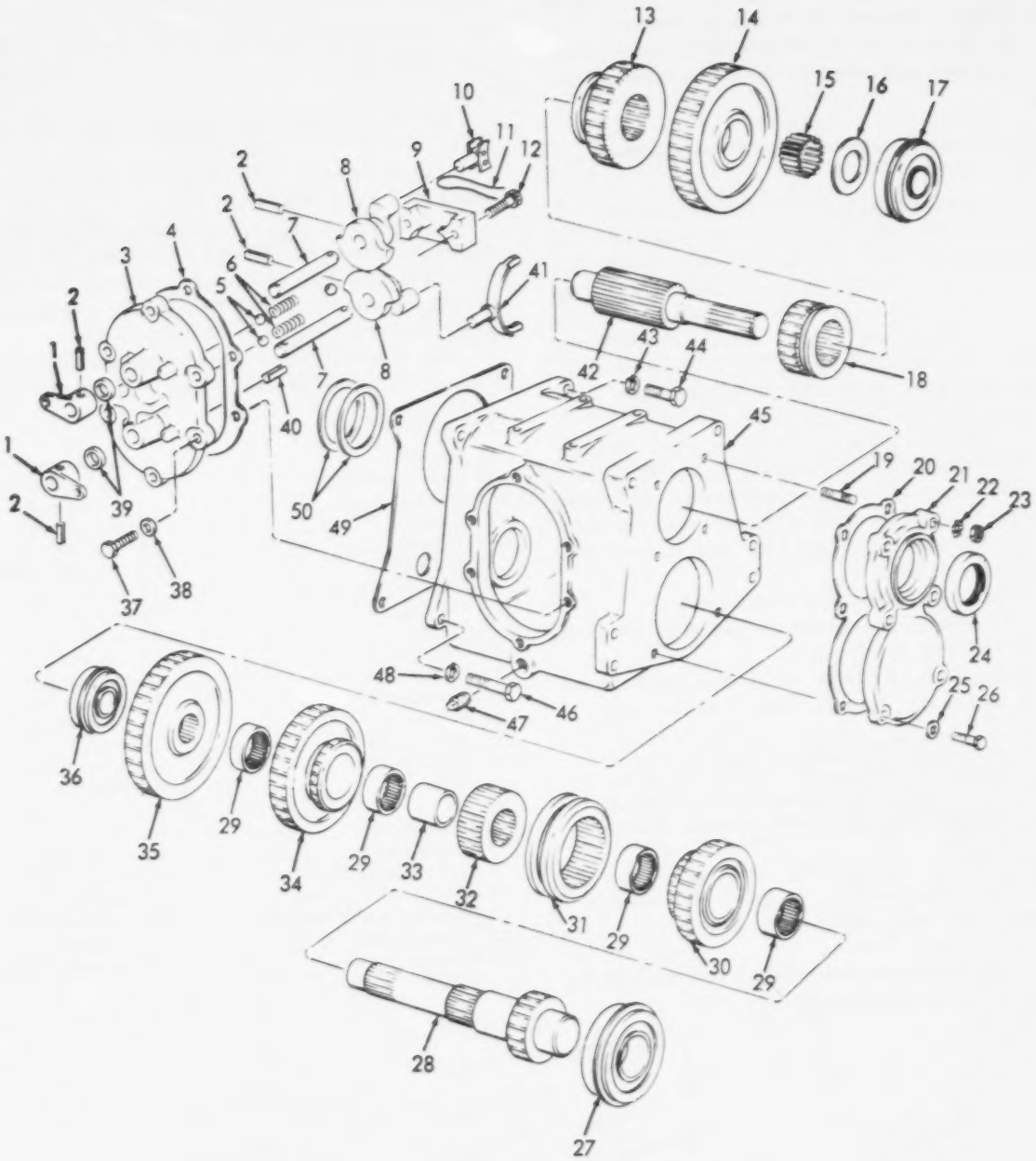


Figure 5-3. Four-speed transmission assembly, exploded view.

b. Disassembly.

(1) Remove the capscrews (26), lockwashers (25), nuts (23), lockwashers (22), rear bearing retainer (21), and gasket (20) from the housing (45). Remove the seal (24) from the retainer (21).

(2) Remove the capscrews (37), lockwashers (38), and side cap assembly from the transmission case.

NOTE

The side cap assembly consists of the parts required for the 4-speed shifting.

(3) Remove the pins (2), arms (1), shafts (7), shift sectors (8), inhibitor block (9), lockwire (11), capscrews (12), shifter fork (10), and shifter fork (41) from the cap (3). Remove and discard the gasket (4). Remove the balls (5) and springs (6).

(4) Remove the output bearing (17), thrust washer (16), needle bearing (15), low gear (14), second gear (13), third gear (18), and main shaft (42) from the upper section of the case (45).

(5) Remove the countershaft rear bearing (27), countershaft (28), shifting collar (31) with hub (32), sleeve (33) and pilot bearings (29), third gear (34), drive gear (35), and front bearing (36).

(6) Remove the shims (50) and gasket (49). Discard the gasket.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Inspect all shafts, gears, and bearings for scoring and wear. Replace any defective parts.

NOTE

Any part incorporating bushings should be replaced if the total radial clearance exceeds 0.0035 inch. Any part incorporating a roller bearing of any type, should be replaced if the total radial clearance exceeds 0.0025 inch.

(3) When assembling gears, check the backlash between mating gears. If the backlash exceeds 0.005 inch, replace the gear(s).

d. Assembly.

(1) Assemble the transmission assembly in the reverse order of disassembly.

(2) Use new gaskets, seals, and packing when assembling.

e. Installation. Install the 4-speed transmission assembly on the shuttle transmission case.

5-7. Converter Housing and Shuttle Transmission

a. Removal.

(1) Remove the control valve assembly (para 5-5).

(2) Remove the 4-speed transmission assembly (para 5-6).

(3) Remove the capscrews (36 and 47, fig. 5-4), lockwashers (37 and 46), capscrews (29, fig. 5-6), and lockwashers (28), and remove the converter housing assembly from the shuttle transmission case. Discard the gasket (45, fig. 5-4).

(4) Remove the primary pump, manifold, and filter (para 5-9) from the shuttle transmission case.

Key to figure 5-4:

1 Capscrew
2 Sealing washer
3 Bearing retainer
4 Gasket
5 Oil seal
6 Bearing
7 Breather
8 Housing
9 Gasket
10 Cover plate
11 Sealing washer (4)
12 Capscrew (2)
13 Bearing
14 Bearing race
15 Thrust washer
16 Shaft
17 Pin
18 Idler gear
19 Thrust washer
20 Cap / dipstick assembly
21 Drain cock
22 Shaft and clutch assembly
23 Thrust washer
24 Bearing
25 Countershaft gear
26 Thrust washer
27 Thrust washer
28 Bearing
29 Idler gear
30 Lockwasher (8)
31 Capscrew (8)
32 Pipe plug
33 Sump
34 Gasket (2)
35 Sump screen
36 Capscrew (2)
37 Lockwasher (2)
38 Shaft
39 Spring pin (2)
40 Shaft
41 Lockwasher
42 Capscrew
43 Cover plate
44 Support tube
45 Gasket
46 Lockwasher
47 Capscrew
48 Expansion plug

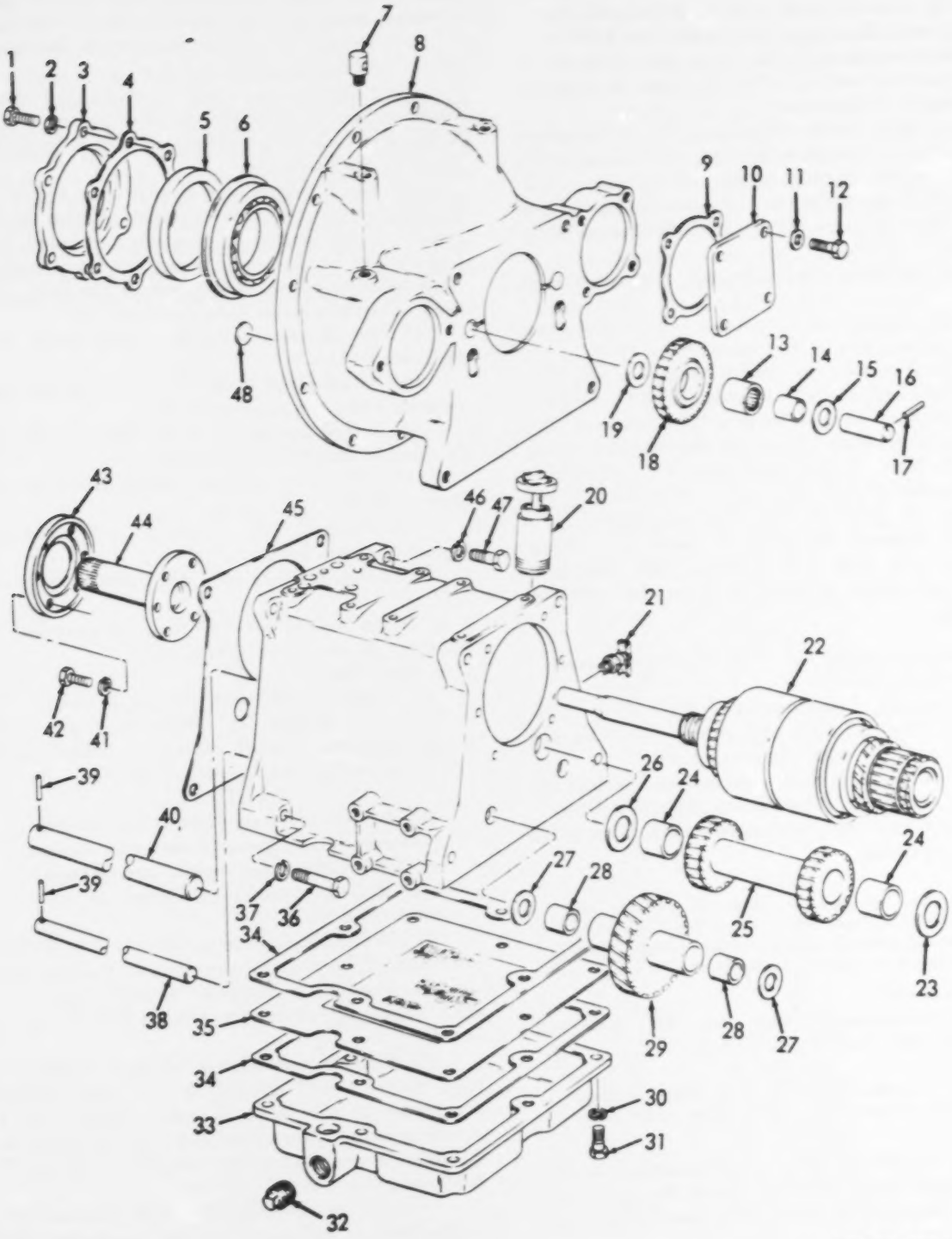


Figure 5-4. Converter housing and shuttle transmission, exploded view.

b. Disassembly.

CAUTION

The countershaft gear shaft (40, fig. 5-4) and idler gear shaft (38) are 0.0020 inch larger at the rear end, and must be removed and installed through the rear end of the housing.

(1) Remove the capscrews (31), lockwashers (30), sump (33), gaskets (34), and sump screen (35) from the bottom of the shuttle case.

(2) Remove the pins (39) and shafts (38 and 40). Allow the gears to drop from the bottom of the case.

(3) Remove the shaft and clutch assembly (22).

(4) Remove the capscrews (42), lockwashers (41), cover plate (43), support tube (44).

(5) Remove the countershaft gear (25), bearings (24), and thrust washers (23 and 26).

(6) Remove the idler gear (29), bearings (28), and thrust washers (27), from the shuttle housing.

(7) Remove the capscrews (1), lockwashers (2), bearing retainer (3), gasket (4), seal (5), and bearing (6) from the converter housing (8).

(8) Remove the pin (17), shaft (16), thrust washer (15), race (14), bearing (13), idler gear (18), and thrust washer (19) from the converter housing.

NOTE

Removal of items 9 thru 12 are not required unless leakage is evidenced.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry with compressed air.

(2) Inspect all shafts, gears, and bearings for scoring and wear. Replace any defective parts.

(3) Clean the magnetized pipe plug (32) before replacing.

NOTE

Tolerances specified in paragraph 5-6*c* are applicable to all transmission components. End play of shafts and gears must not exceed 0.035 inch. Correct with shims as required during assembly.

d. Assembly.

(1) Assemble the idler gear (29), loose roll bearings (28), and thrust washers (27).

NOTE

Insert a thrust washer, 16 loose rollers, a thrust washer, 16 loose rollers, and a thrust washer in the gear.

(2) Install the idler gear assembly in the transmission case; aline and insert the shaft (38) with the large end toward rear of case. Secure with pin (39).

(3) Assemble the countershaft gear (25), bearings (24), and thrust washers (23 and 26). Insert a safety wire through the assembly and insert into the case with the larger gear at the rear of the case. With the safety wire projecting from both ends of the case, above the countershaft gear assembly down into the lower corner of the case.

(4) Install the support tube (44) and cover plate (43) in the case.

(5) Lubricate the seals, bearings, and clutch plates and insert the clutch and shaft assembly (22) in the case. *Do not damage the seal rings at the head of the assembly.*

(6) Use a pair of long screwdrivers and work the countershaft gear into its proper position. Make sure the thrust washers are properly positioned, and remove the safety wire. Insert the countershaft (40), small end first, in the rear of the case, and press or tap into place. Secure with pin (39).

(7) Install new gaskets (34), sump screen (35) and sump (33).

(8) Attach items in step (7) above using lockwashers (30) and capscrews (31).

(9) Install the converter housing assembly on the shuttle transmission housing.

(10) Install the primary pump, manifold and filter assembly (para 5-9).

(11) Install the 4-speed transmission assembly (para 5-6).

(12) Install the control valve assembly (para 5-5).

e. Installation. Install the transmission assembly in the crane (para 2-8).

f. Stall Test.

(1) Apply service and parking brakes.

(2) Run engine at 1000-1200 rpm with transmission and F-N-R control in neutral until engine operating temperature is reached.

CAUTION

Do not exceed 30 seconds at full throttle converter stall; between test, run engine at 1000-1200 rpm, with transmission and F-N-R control inneutral to cool converter oil

(3) With transmission in neutral, place F-N-R control in "F" and depress accelerator to wide open throttle position; tachometer should read 2300 rpm. Repeat this procedure with the F-N-R control in "R".

(4) Place transmission in 4th gear, transfer in high range, F-N-R control in "F" and depress accelerator to side open throttle position with a steady pressure. The tachometer reading should be 2100-2150 rpm. Repeat this procedure with the F-N-R control in "R".

(a) If stall exceeds 2200 rpm, transmission malfunction is indicated; release accelerator and shift into neutral immediately to avoid transmission, damage.

(b) If stall speed is 1900 rpm ± 50 rpm transmission malfunction is indicated.

(c) If stall speed is 1800 rpm or has the torque converter is malfunctioning. Disassemble converter and repair or replace worn parts as required, (para c above).

5-8. Shaft and Clutch Assemblies

a. General. The shaft and clutch assemblies (22, fig. 5-4) are integral parts of the shuttle transmission assembly. Each clutch assembly is similar in design, consisting of a series of bronze friction plates alternately assembled with polished steel reaction plates. A hydraulically-operated clutch piston and cylinder assembly associated with each clutch assembly provides forward and reverse operation through the control valve assembly.

b. Removal. Remove the shaft and clutch assemblies (para 5-7).

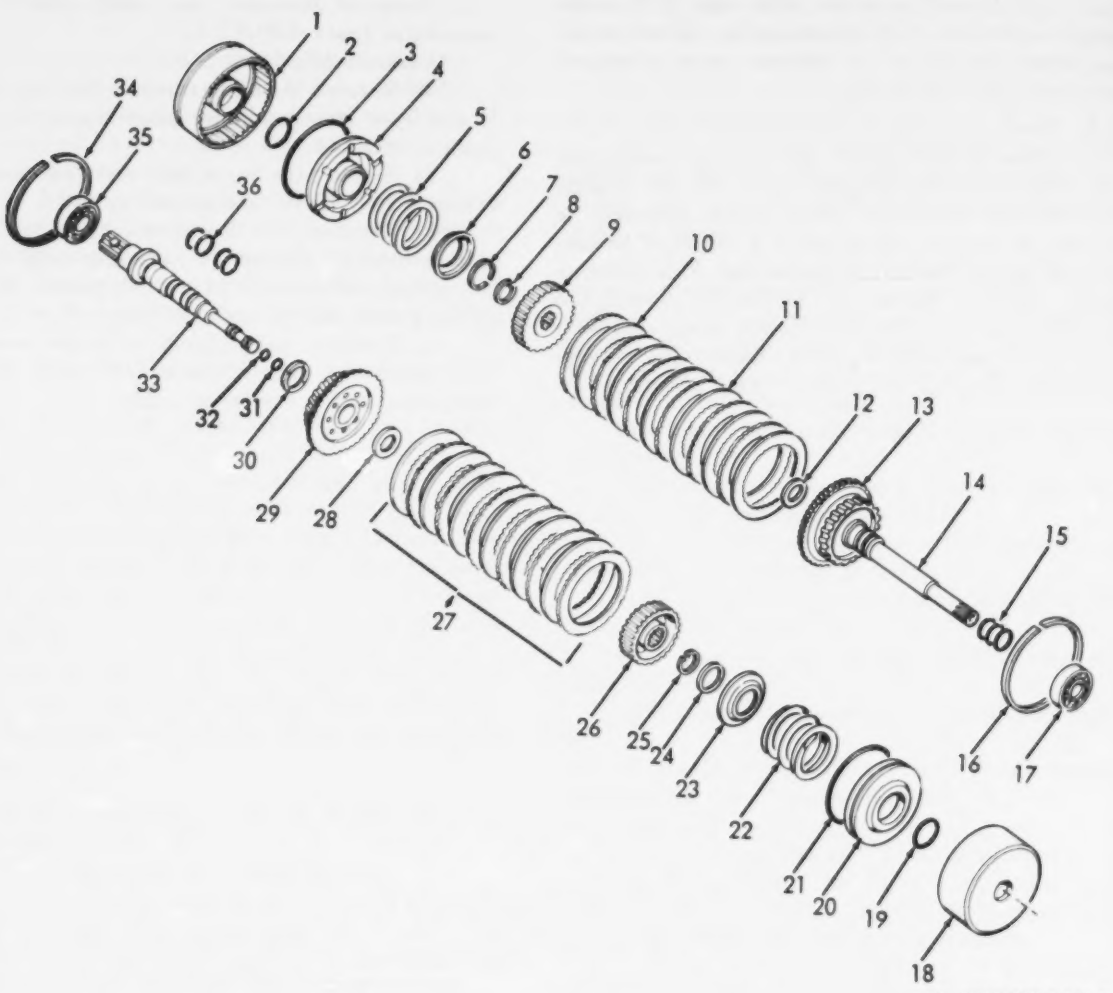
c. Disassembly.

(1) Remove the outer retainer ring (16, fig. 5-5) and front clutch cylinder assembly (1) from the input shaft (14).

(2) Remove the input shaft and gear assembly (13 and 14). Remove the bearing (17).

(3) Remove the thrust washer (12), clutch plate assembly (10 and 11), retainer rings (7 and 8,), spring and retainer (5 and 6), piston (4), and packing and seal (2 and 3).

(4) Remove rear clutch cylinder assembly (18) from the output shaft (33), and remove components in a similar manner.



1 Clutch cylinder assembly
2 Preformed packing
3 Seal
4 Piston
5 Spring
6 Spring retainer
7 Retainer ring
8 Retainer ring
9 Hub
10 Reaction plate (8)
11 Friction plate (8)
12 Thrust washer
13 Input gear assembly
14 Input shaft
15 Seal rings (4)
16 Retainer ring
17 Pilot bearing
18 Clutch cylinder assembly
19 Preformed packing
20 Piston
21 Seal ring
22 Spring
23 Spring retainer
24 Retainer ring
25 Retainer ring
26 Hub
27 Clutch plate assembly (same as items 10 and 11)
28 Thrust washer
29 Output gear
30 Washer
31 Seal ring
32 Preformed packing
33 Output shaft
34 Retainer ring
35 Bearings
36 Seal rings

Figure 5-5. Shaft and clutch assemblies, exploded view.

d. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Inspect all parts for excessive wear, scoring, cracks or other damage. Rotate all bearings by hand to detect roughness or excessive play. Check all splined and toothed parts for damage and wear. Remove all light scoring with a lapping stone or fine crocus cloth. Replace all defective parts.

e. Assembly.

NOTE

Use new seals, gaskets, and packing when assembling. Lubricate with clean engine oil prior to installation.

(1) Insert new packing (19) in the cylinder (18); install the seal ring (21) on the piston (20), and place in the cylinder. Insert the spring (22) and retainer (23); compress the spring and secure with the retainer (24).

(2) Install a set of clutch plates (10 and 11) (eight friction and eight reaction plates). Install a steel reaction plate against the piston (20) with the "disced" surface of the place toward the installer. Then install a bronze friction plate, and alternately install the remaining plates.

(3) Press the output shaft bearing (35) on the shaft (33), installing double seal rings (36) on each side of the bearing.

(4) Install the packing (32), seal ring (31), washer (30), output gear (29), and thrust washer (28) on the output shaft (33). Install the hub (26) on the shaft, thrust face down. Secure with retainer (25).

(5) Install the clutch cylinder assembly on the output shaft and secure with the retainer ring (34).

CAUTION

Before installing the clutch cylinder assembly, make sure that the missing external teeth in the steel plates are alined with the oil drain holes in the clutch cylinder.

(6) Assemble the front clutch cylinder (1) in the reverse order of disassembly.

(7) Lower the front clutch assembly in place on the output shaft, checking the plate and drain hole alinement as specified above.

(8) Install the retainer ring (8), clutch hub (9), and thrust washer (12).

(9) Install the bearing (17) on the input shaft (14).

(10) Lower the assembly carefully into the front clutch cylinder (1). Install the retainer ring (16) in the cylinder. Install the seal rings (15) on the input shaft.

f. Installation. Install the shaft and clutch assemblies in the shuttle transmission (para 5-7).

5-9. Primary Pump, Oil Manifold, and Oil Filter Assemblies

a. Removal.

(1) Remove the brace (9, fig. 5-6), tubes (10 and 25), and packing (2) from the manifold (1).

(2) Remove the two capscrews (29) and sealing washers (28) and remove pump, manifold, and filter from converter housing. Discard gasket (21).

b. Disassembly.

(1) Remove the stud (11), packing (2), cover (8), packing (7), and filter element (6) from the manifold (1).

(2) Remove the pin (4), spring (5), ball (23), and packing (3) from the manifold.

(3) Remove the four capscrews (22) and lockwashers (24). Remove the manifold from the pump back plate (32).

(4) Remove the locknut (26) and pump drive gear (27) from the drive gear assembly (34). Remove the key (35).

NOTE

Make an identification mark across the front plate, body, and rear plate before disassembling the pump.

(5) Remove four capscrews (31) and separate the front plate assembly (20), body (14), and back plate assembly (32). Remove gears (33) and (34), seal (15), gaskets (16 and 17), springs (18), balls (19), and diaphragm (12).

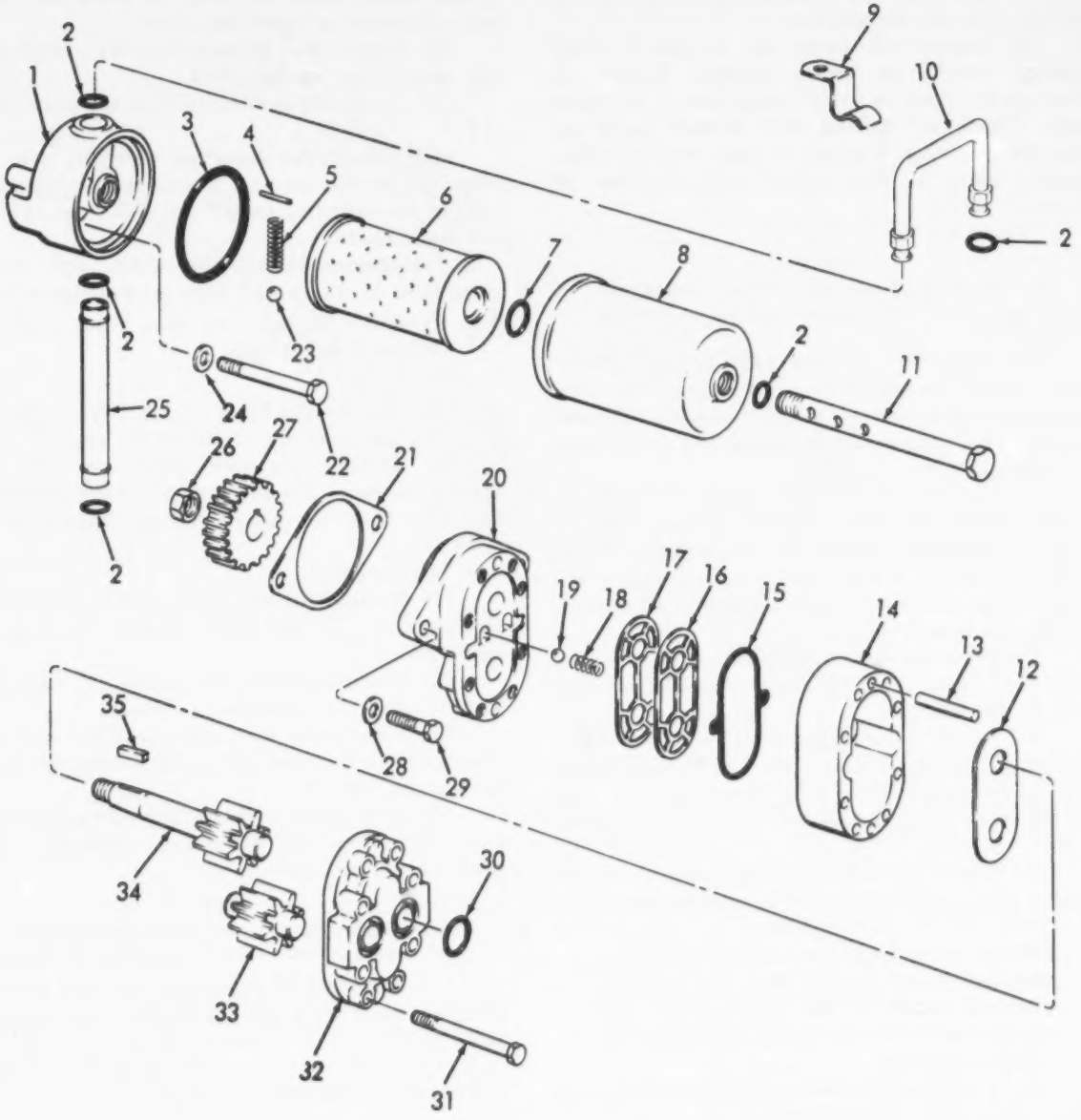


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Figure 5-6. Primary pump, oil manifold, and oil filter assemblies, exploded view.

Key to figure 5-6:

1 Manifold
2 Preformed packing
3 Preformed packing
4 Pin
5 Spring
6 Filter element
7 Preformed packing
8 Cover
9 Brace
10 Tube
11 Stud
12 Diaphragm
13 Pin
14 Body
15 Seal
16 Gasket
17 Gasket
18 Spring
19 Ball
20 Front plate assembly
21 Gasket
22 Capscrew
23 Ball
24 Lockwasher
25 Tube
26 Locknut
27 Gear
28 Sealing washer
29 Capscrew
30 Preformed packing
31 Capscrew
32 Backplate assembly
33 Idler gear
34 Drive gear assembly
35 Key

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Inspect gears and shafts for scoring and wear. Remove light scoring with a lapping stone.

(3) Check the clearance between the shafts and bushings in the front and back plate assemblies. If the total radial clearance exceeds 0.0035 inch, the shafts and plates must be replaced.

NOTE

Because of the close tolerances involved in the manufacture of the pump, it is recommended that the entire pump be replaced rather than attempting to replace the plates and / or shafts.

d. Assembly.

CAUTION

Use new gaskets and packing when assembling.

(1) Install the gears (33 and 34) in the back plate (32). Insert the pins (13) in the body (14).

(2) Insert the capscrews (31) through the back plate and body. Place the diaphragm (12) over the gear shafts.

(3) Install the balls (19), springs (18), gaskets (16 and 17), and seal (15) in the front plate (20). Aline the plates and body in accordance with the identification mark made prior to disassembly.

(4) Tighten the capscrews to a torque of 27-30 ft-lb.

(5) Install new back packing (30).

(6) Install the key (35), gear (27), and locknut (26) on the drive gear assembly (34).

(7) Install the manifold (1) on the back of pump with capscrews (22) and lockwashers (24).

(8) Install ball (23), spring (5), and pin (4) in manifold.

(9) Install packing (3), filter element (6), packing (7), cover (8), and packing (2) in manifold. Secure with stud (11).

(10) Install tubes (10 and 25) and packing (2).

e. Installation. Install the complete assembly on the converter housing and secure with capscrews (29) and lockwashers (28). Tighten capscrews to 27-30 ft-lb. torque.

5-10. Drive Plate and Converter Assembly

a. General. The drive plate assembly is bolted to the engine flywheel, and in turn, is bolted to the torque converter assembly. The torque converter, in turn, is connected to the shuttle transmission, providing the fluid drive connection for the vehicle.

NOTE

The principal cause of faulty operation of the converter is due to leaking seal rings.

b. Removal.

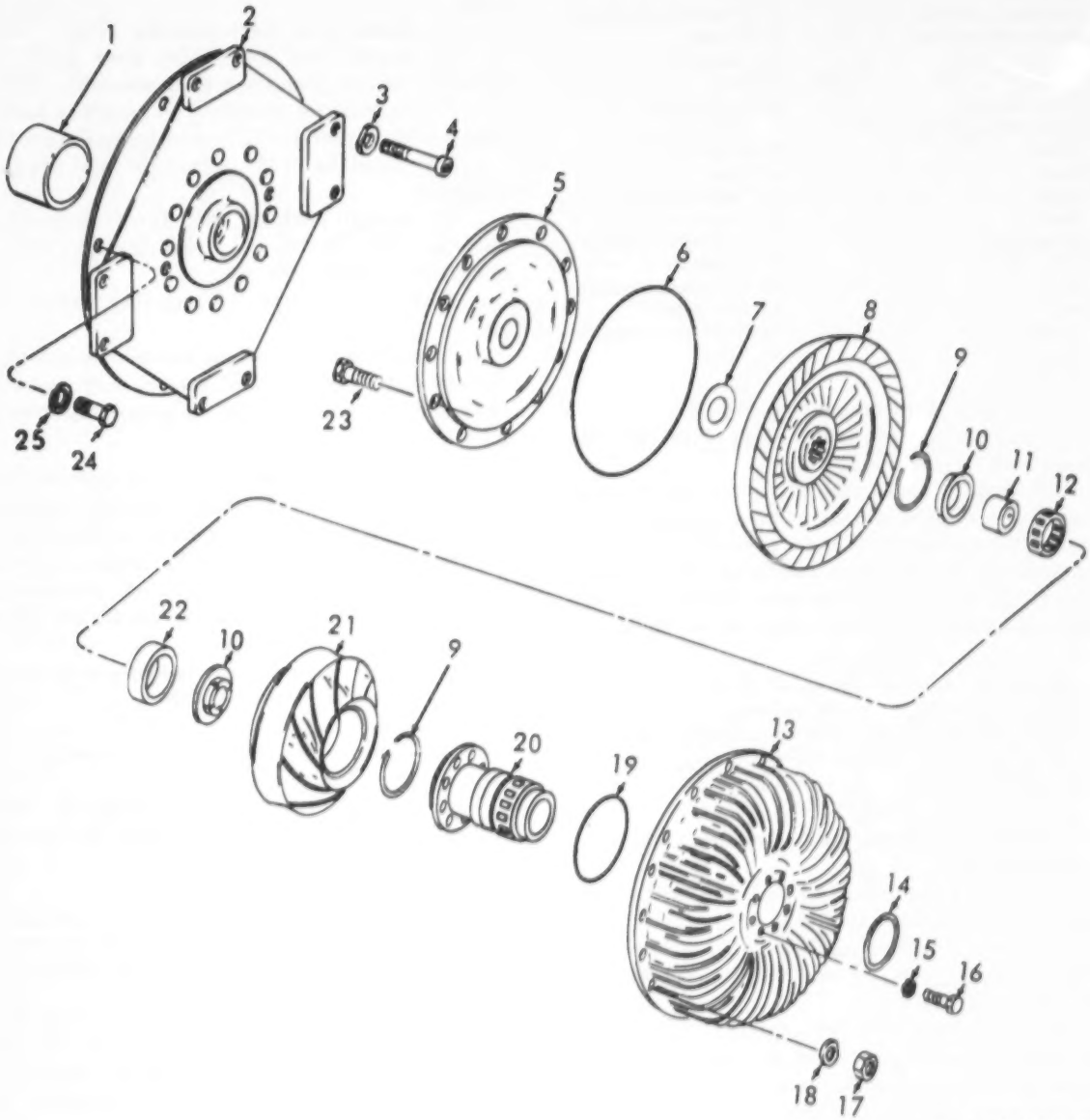
(1) Remove the transmission assembly (para 2-8).

(2) Remove the eight socket-head screws (4, fig. 5-7) and washers (3). Remove the converter assembly.

NOTE

Removal of the drive plate assembly (2) and hub sleeve (1) from the flywheel will not be required unless damage to these items is noted during inspection.

(3) Place the converter, front cover up, on the work bench. Support the assembly on wood blocks forming an eight-inch square (inside dimension). This will provide clearance for the impeller gear hub.



1 Hub sleeve
2 Drive plate assembly
3 Washer
4 Capscrew
5 Front cover
6 Preformed packing
7 Thrust washer
8 Turbine assembly
9 Retainer ring
10 Thrust washer
11 Inner race
12 Sprag (one-way clutch)
13 Impeller assembly
14 Seal
15 Lockwasher
16 Capscrew
17 Locknut
18 Lockwasher
19 Preformed packing
20 Gear hub
21 Stator assembly
22 Outer race
23 Capscrew
24 Capscrew
25 Lockwasher

Figure 5-7. Drive plate and converter assembly, exploded view.

c. Disassembly.

(1) Remove the locknuts (17), lockwashers (18), and capscrews (23).

(2) Remove the front cover (5), packing (6), and thrust washer (7).

(3) Remove stator and sprag assembly (21).

CAUTION

Exercise care in removal of thrust washers and bearing races to prevent damage to the machined surfaces.

(4) Remove retainer rings (9), thrust washers (10), sprag (12), inner race (11), and outer race (22).

NOTE

The thrust washers (10) are a two piece item. Be sure to note their relationship upon removal so they may be installed correctly upon reassembly.

(5) Remove capscrews (16) and lockwashers (15).

(6) Remove seal ring (14), gear hub (20), and packing (19) from the impeller assembly (13). *Discard packing and seal ring.*

d. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Inspect all parts for scoring, or excessive wear. Inspect the faces of the thrust washers (10) carefully. If scored or worn, replace.

NOTE

If the sprag (12) is to be replaced, replace the inner and outer races (11 and 22).

e. Assembly.

(1) Lay the stator assembly (21) on the bench with side marked "front" up. Insert a retainer ring (9) in the lower groove. Insert a thrust washer (10) with the counterbored side up.

(2) Insert the outer race (22) and sprag (12) with the flanged edge up. Insert the inner race (11) with the splined end up. Insert the second thrust washer (10), counterbore down, and install the retainer ring (9).

(3) Install the hub (20) and packing (19) in the impeller assembly (13). Secure with the capscrews (16) and lockwashers (15).

(4) Install the stator assembly (21) on the hub (20), and the turbine assembly (8) on the thrust washer on the top of the stator assembly.

(5) Install new packing (6) in the front cover (5). Place the cover on the impeller assembly (13) and secure with the capscrews (23), lockwashers (18), and nuts (17). Tighten to a torque of 22 ft-lb.

f. Installation.

(1) Install the converter assembly on the drive plate and secure with the eight sockethead capscrews (4) and washers (3). Torque to 16 foot-pounds.

(2) Coat a new seal ring (14) lightly with grease and center in its groove in impeller (13).

(3) Install the transmission (para 2-8).

CAUTION

Support transmission with hoist so that it can be positioned directly in line with converter hub. Carefully insert input shaft into bore of hub. Slide gently forward until splines begin to mate. DO NOT USE FORCE if unit stops advancing. Rock the transmission gently; the splines will mate and the unit will close up easily.

5-11. Shift Control Levers

a. General. Two shift control levers, located in the crane cab at the right of the operator, control the selection of the gear ratios in the 4-speed transmission and transfer case.

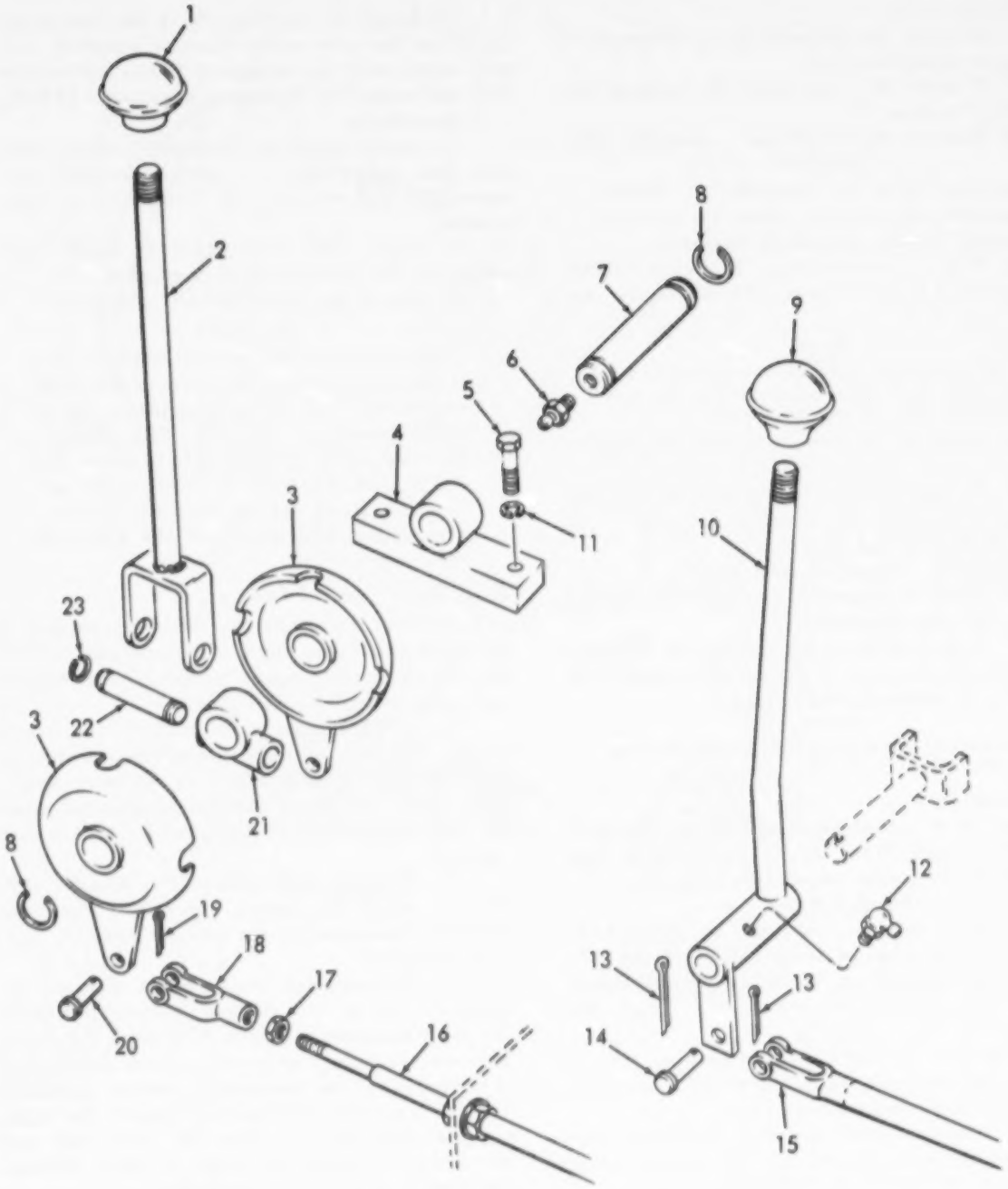
(1) *Transmission shift control.* The transmission shift control lever selects through the two shells, the four speed provided by the transmission. The neutral (no-drive) position is provided when the lever is in an upright position with neither shell engaged.

(2) *Transfer shift control.* The transfer shift control selects two speeds through a rigid rod assembly connected to the transfer case.

b. Removal.

(1) *Transmission shift control.* Remove the cotter pin (19, fig. 5-8) and pin (20) from the shells (3) and disconnect the clevis (18) from the shells. Remove two screws and washers from the bracket (4) and remove the transmission control assembly.

(2) *Transfer shift control.* Remove the cotter pin (13) and pin (14) from the lever (10) and disconnect the clevis (15) from the lever. Remove the transfer shift control assembly.



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1 Ball
2 Lever
3 Shell (2)
4 Bracket
5 Capscrew (2)
6 Grease fitting
7 Pin
8 Retaining ring (2)
9 Ball
10 Lever
11 Lockwasher
12 Grease fitting
13 Cotter pin (2)
14 Pin
15 Clevis and rod
16 Control cable assy.
17 Nut
18 Clevis
19 Cotter pin
20 Pin
21 Knuckle
22 Pin
23 Retaining ring

Figure 5-8. Shift control levers, exploded view.

c. Disassembly.

(1) *Transmission shift control.*

(a) Remove the retainer ring (8), shells (3), and lever (2) from the pin (7). Remove the retainer (8) and the fitting (6) from the opposite end of the pin (7).

(b) Remove the pin (7) from the bracket (4). Remove the ball (1) from the lever (2).

(c) Remove the retainers (23), pin (22), and knuckle (21).

(2) *Transfer shift control.* Remove the cotter pin (13) from the pin and release the lever (10). Remove the ball (9) and fitting (12) from the lever.

d. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Inspect all parts for excessive wear or damage.

e. Assembly and Installation.

(1) *Transmission shift control.* Assemble and install in reverse order of removal and disassembly.

NOTE

The travel should be 1½ to 1⅝ inches when the shift lever is moved from neutral to any position.

(2) *Transfer shift control.* Assemble and install in reverse order of removal and disassembly.

NOTE

The transfer shift rod should travel ¼-inch when moved from neutral to either the HI or LO position. Adjust the clevises accordingly.

CHAPTER 6

REPAIR OF TRANSFER CASE

Section I. TRANSFER CASE

6-1. General

The transfer case is mounted behind, and connected to the transmission by a short drive shaft. In turn, the transfer case is connected to the rear and front drive axles by means of shafts equipped with universal joints. A HI-LO speed range (1.215:1 and 2.365:1) to the drive axles is provided by the shift control (fig. 5-8) located in the crane cab. In addition to the gearing components, a traction lock system is incorporated in the transfer case to overcome loss of traction on either axle. This feature is controlled by the crane operator by means of a panel control switch.

6-2. Removal and Disassembly

a. Remove the transfer case in accordance with the instructions given in paragraph 2-9.

b. Place the transfer case on the workbench or stand for disassembly.

c. Remove the nuts (28 and 55, fig. 6-1), washers (27, 54, and 98), and yokes (26, 53, and 97).

d. Remove the screws (108), lockwashers (109), gaskets (103 and 115), and covers (107-116).

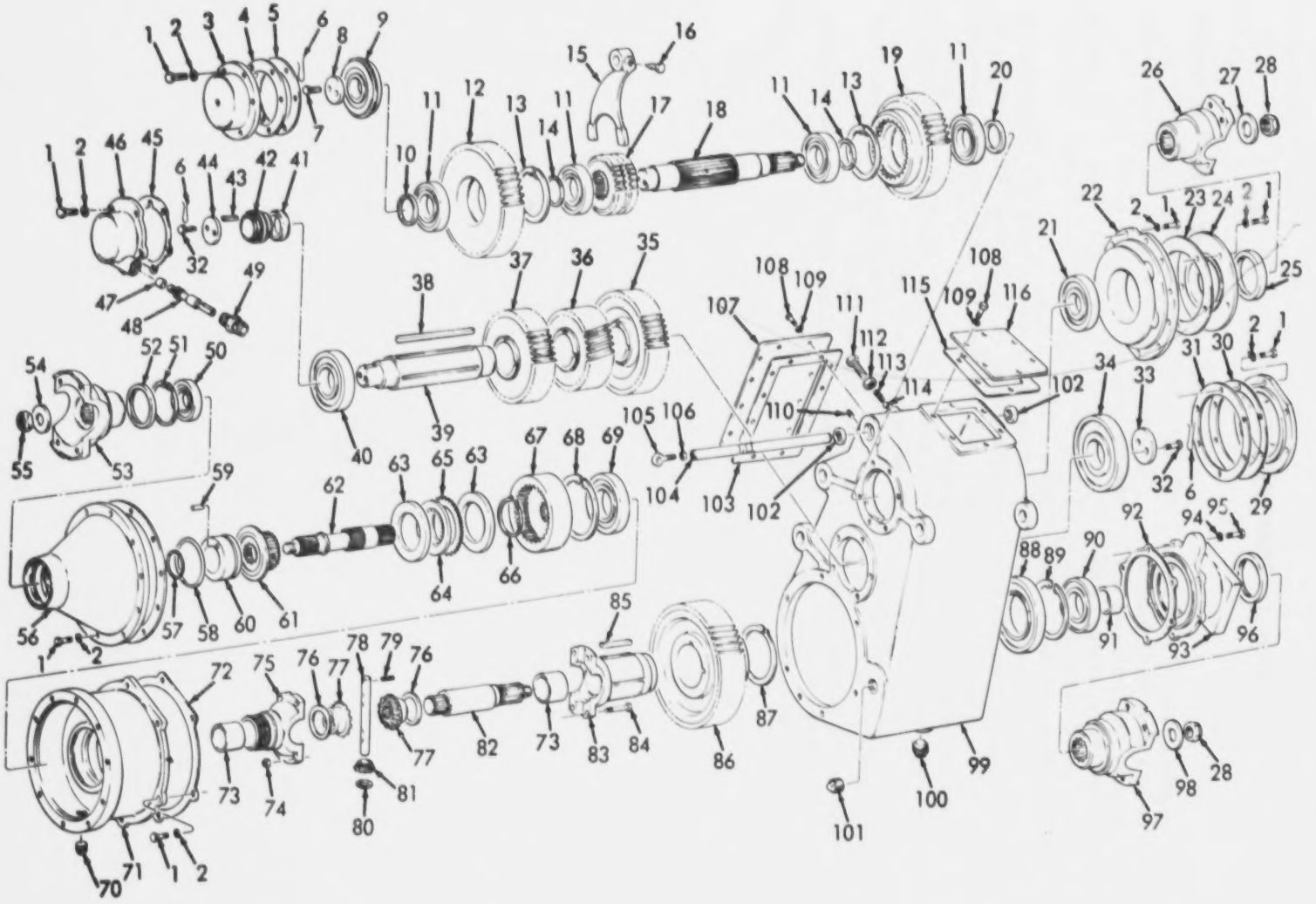
e. Remove the screw (111), nut (112), spring (113), ball (114), setscrew (16), shaft (104), and clevis (15).

f. Remove the screws (1 and 95), lockwashers (2 and 94), shims (4, 5, 30, and 31), covers (3, 29, and 56), housings (46 and 71), and associated gaskets.

g. Remove the input shaft (18) and associated ırs, bearings, and seals.

h. Remove the countershaft (39) and associated gears, bearings, and seals.

i. Remove the output shaft (82) and associated components.



ME 3810-233-34/6-1

Figure 6-1. Transfer case, exploded view.

Key to figure 6-1:

1 Screw
2 Lockwasher
3 Cover
4 Shim - .005
5 Shim - .020
6 Wire
7 Screw
8 End plate
9 Bearing
10 Spacer
11 Bearing
12 Gear
13 Retaining ring
14 Spacer
15 Clevis
16 Setscrew
17 Shift cone
18 Input shaft
19 Gear
20 Spacer
21 Bearing
22 Retainer
23 Gasket
24 Retainer
25 Seal
26 Yoke
27 Washer nut
28 Nut
29 Cover
30 Shim - .020
31 Shim - .005
32 Screw
33 End plate
34 Bearing
35 Spur gear
36 Drive gear
37 Spur gear
38 Key
39 Countershaft
40 Bearing
41 Spacer
42 Gear
43 Key
44 End plate
45 Gasket
46 Housing
47 Bushing
48 Gear
49 Sleeve
50 Bearing
51 Retaining ring
52 Seal
53 Yoke
54 Washer
55 Nut
56 Cover
57 Packing
58 Packing
59 Pin
60 Bearing
61 Clutch cone
62 Shaft
63 Spacer
64 Friction disk
65 Opposing disk
66 Retaining disk
67 Clutch disk
68 Retaining ring
69 Bearing
70 Pipe plug
71 Clutch housing
72 Gasket
73 Bushing
74 Nut
75 Front diff. case
76 Thrust washer
77 Gear
78 Pinion shaft
79 Roll pin
80 Thrust washer
81 Diff. pinion
82 Shaft
83 Rear diff. case
84 Screw
85 Key
86 Gear
87 Retaining ring
88 Bearing
89 Retaining ring
90 Bearing
91 Spacer
92 Gasket
93 Retainer
94 Lockwasher
95 Screw
96 Seal
97 Yoke
98 Washer
99 Transfer case
100 Pipe plug
101 Pipe plug
102 Seal
103 Gasket
104 Shaft
105 Rod end
106 Nut
107 Cover
108 Screw
109 Lockwasher
110 Pipe plug
111 Screw
112 Nut
113 Spring
114 Ball
115 Gasket
116 Cover

6-3. Cleaning, Inspection, and Repair

a. Clean all parts, including the transfer case, with an approved cleaning solvent. Dry thoroughly with compressed air.

b. Inspect all gears and shafts for wear and scoring. Remove light scoring with a lapping stone or fine crocus cloth. Replace any shaft or gear with deep scoring or signs of excessive wear.

c. Rotate all bearings by hand to detect any signs of roughness or damage. Replace as required.

NOTE

Any bearing with a total radial clearance in excess of 0.0025 inch or bushing in excess of 0.0035 inch should be replaced. Any shaft with an end play in excess of .0250 should be replaced.

d. Inspect the discs of the traction lock (64 and 65) for wear. If wear is noticeable, replace the disc assembly.

6-4. Assembly and Installation

a. Assemble the component parts of the transfer case in the reverse order of disassembly. *Use new gaskets, packing, and seals when* assembling. Tighten all screws to the torque specified in table 1 for the respective screw and nut sizes.

b. Install the transfer case in the carrier (para 2-9).

Section II. TRACTIONLOCK SYSTEM

6-5. General

The traction lock system incorporated in the carrier drive system to compensate for loss of traction on any wheel or either axle is an air controlled-hydraulic system. The system is engaged or disengaged by means of a toggle type air valve located on the instrument panel. The power cluster is essentially an air chamber coupled directly to a brake master cylinder for approximately a 1:8 ratio step up from the air pressure input to the hydraulic output. The pressurized hydraulic fluid then engages the clutches in the axles and transfer case for complete, positive traction.

6-6. Power Cluster

a. Removal.

(1) Disconnect the air supply tube assembly from the air chamber shell.

(2) Disconnect the hose assembly to the transfer case, and drain the system as much as possible.

(3) Disconnect the two tube assemblies to the front and rear axle assemblies.

(4) Remove three capscrews (25, fig. 6-2) and lockwashers (24) that secure the power cluster to mounting bracket (26).

(5) Removal of capscrews (27), nuts (29), lockwashers (28), and mounting bracket (26) is necessary only if damaged and replacement is necessary.

Key to figure 6-2:

1 Shell	16 Cup
2 Screw, assembled washer	17 Cup
3 Piston cup & spring assy.	18 Spring & retainer assy.
4 Piston wiper	19 Pipe plug
5 Rod & piston assy.	20 Gasket
6 Spring	21 Master cylinder body
7 Boot	22 Lockwasher
8 Cylinder head assy.	23 Capscrew
9 Retainer	24 Lockwasher
10 Filter	25 Capscrew
11 Filter screen	26 Mounting plate assy.
12 Spacer	27 Capscrew
13 Retaining ring	28 Lockwasher
14 Plate	29 Nut
15 Piston assy.	30 Stroke indicator assy.

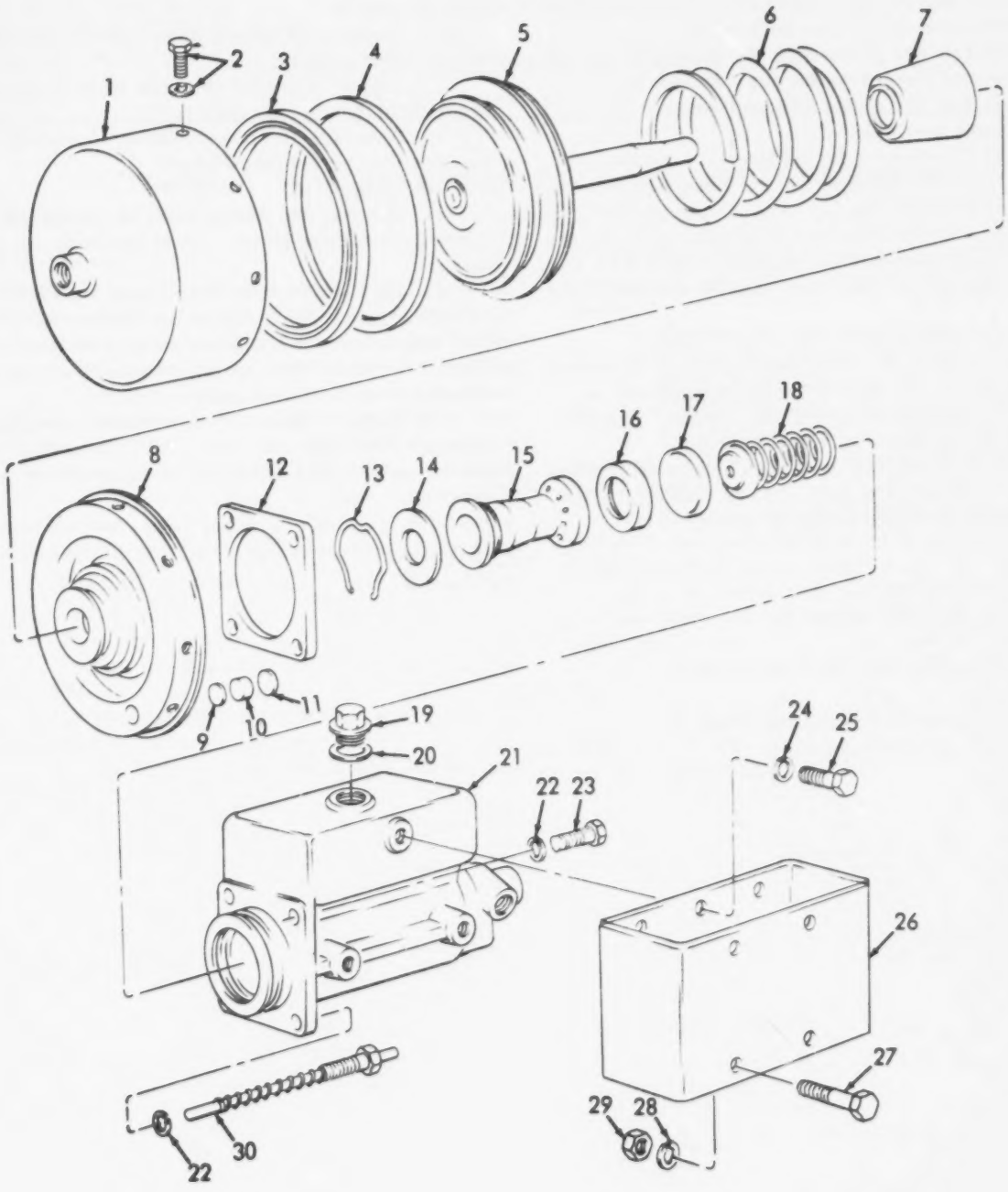


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Figure 6-2. Power cluster assy., exploded view.

b. Disassembly.

(1) Remove stroke indicator assembly (30) and lockwasher (22).

(2) Remove three capscrews (23) and lockwashers (22) and separate air chamber from master cylinder, removing the spacer (12).

(3) Remove eight capscrews with lockwashers (2) that secure shell (1) to the head (8).

(4) Lift out piston and rod assembly (5) and remove and discard piston cup (3) and wiper (4).

(5) Lift off spring (6) and remove boot (7) from head assembly (8).

(6) If necessary for replacement, retainer (9), filter (10), and filter screen (11) can be removed.

(7) Remove plug (19) and discard gasket (20).

(8) Remove retainer ring (13) and lift out plate (14), piston (15), cups (16 and 17) and spring assembly (18) from master cylinder body (21).

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent, and dry with compressed air.

(2) Inspect all parts for cracks, scratches, burrs, sharp edges or other damage.

(3) Remove any burrs and break sharp edges found. Replace any part that is cracked, deeply scratched or otherwise badly damaged.

d. Assembly.

(1) Replace all rubber cups, wipers, and the boot with new parts.

(2) Lightly lubricate all parts with hydraulic brake fluid before reassembly.

(3) Assemble the power cluster in reverse of disassembly, paragraph *b* above.

e. Installation.

(1) Reverse the instructions of paragraph *a* above to install the power cluster assembly on the carrier.

(2) Fill the system with hydraulic brake fluid.

(3) Operate the system a few times with plug (19) still removed to bleed any air pockets from the lines and hoses. When system is completely bled, reinstall plug (19) and gasket (20).

(4) Refer to figure 1-9 and attach a pressure gage (0-1000 psi) at point "A". Operation of system must show a minimum pressure of 650 psi.

CHAPTER 7

REPAIR OF CARRIER RUNNING GEAR

Section I. PLANETARY, WHEEL HUB AND BRAKE ASSEMBLIES

7-1. General

Each axle mounts two planetary, wheel hub, and brake assemblies. The front and rear assemblies are identical with the exception of the rear brake assemblies, which include an additional braking feature (parking brakes). The braking chambers differ in that the rear braking system uses a dual-diaphragm chamber, whereas the front chamber is a single-diaphragm unit. The brake assembly components are identical, and the disassembly, repair, and installation details are the same. Disassembly does not require removal of the axle.

7-2. Planetary, Wheel Hub, and Brake Assemblies

a. Removal.

(1) Remove the wheel assembly (TM 5-3810-233-12).

(2) Remove the plug (30, fig. 7-1) from hub (28) and drain the lubricant.

(3) Remove the brake chamber (TM 5-3810-233-12).

(4) Remove the capscrews (1, fig. 7-1), lockwashers (2), cover (3), and gasket (4). *Discard the gasket.*

(5) Remove the capscrews (32), lockwashers (33), and capscrews (34).

(6) Remove thrust button (5), retaining ring (6), "sun" gear (7), and thrust washer (8).

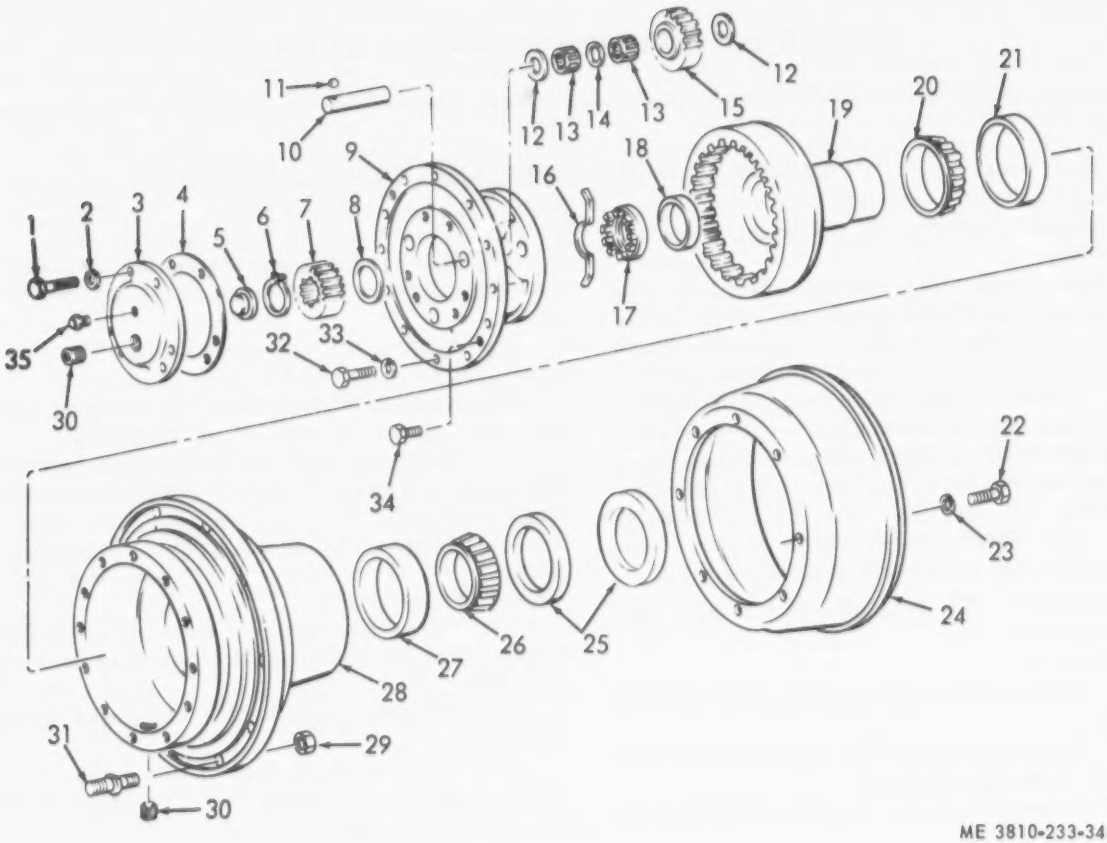
(7) Insert two bolts in the threaded holes in the spider (9), and with suitable puller, remove the spider assembly.

(8) Remove the skein locknut keys (16). Remove the skein locknut (17) with the skein locknut wrench (table 2-1).

(9) Remove the ring gear assembly (19). The bearing cone (20) will remain attached to the ring gear hub.

(10) Remove the hub (28) and brake drum (24).

(11) Remove the springs (2 and 4, fig. 7-2), rollers (3 and 19), retaining ring (10), brake shoes (1) and anchor pin (20).



1 Capscrew (6)
2 Lockwasher (6)
3 Cover
4 Gasket
5 Thrust button
6 Retainer ring
7 Gear, spur (sun)
8 Thrust washer
9 Spider
10 Pin, planetary gear (3)
11 Ball (3)
12 Thrust washer (12)
13 Roller bearing (6)
14 Spacer (3)
15 Planetary gear (3)
16 Key (2)
17 Locknut, skein
18 Bushing
19 Ring gear
20 Bearing cone
21 Bearing cup
22 Capscrew (8)
23 Lockwasher (8)
24 Brake drum
25 Seal
26 Bearing cone
27 Bearing cup
28 Hub
29 Nut (10)
30 Magnetic plug (2)
31 Wheel stud (10)
32 Capscrew (12)
33 Lockwasher (12)
34 Capscrew (2)
35 Pressure relief fitting

Figure 7-1. Planetary outer end, wheel hub and brake assemblies, exploded view.

b. Disassembly.

(1) Remove the retainer ring (13, fig. 7-2) slack adjuster (14), spacer (15), seals (7), bushings (8), washer (6) and actuating shaft (5) from the spider (9).

(2) Remove the nuts (12), lockwashers (11), spider (9), and dust shield (16).

(3) Remove capscrews (22, fig. 7-1) and lockwashers (23). Remove brake drum (24) from hub (28).

(4) Remove seal (25, fig. 7-1) and bearing cone (26) from hub (28).

(5) Press out pins (10) and ball (11) from spider (9) and remove planetary gears (15).

(6) Remove thrust washers (12), needle bearings (13), and spacers (14), from planetary gears.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly with compressed air.

NOTE

Do not immerse the brake linings in solvent. Wipe clean with a moistened cloth. Remove glazed spots with fine abrasive cloth.

(2) Measure the brake lining thickness. If worn to dimension indicated in figure 7-2, replace the linings.

(3) Inspect the brake drum for scoring. Remove scoring by turning on a lathe but do not turn in excess of 17.325 to 17.335 inches inside diameter. This will allow 0.040 inch wear after reboring. If these dimensions are exceeded, replace the brake drum.

(4) Inspect bearings, needle and roller, for rough spots. Rotate by hand to detect roughness. Inspect bearing cups for surface smoothness. Replace thrust washers if scored. Replace parts as required.

(5) Inspect the spur "sun" gear (7), planetary gears (15), and ring gear (19) for wear on teeth. The normal backlash is 0.007 to 0.011 inch. If the backlash exceeds 0.018 inch, replace the gears.

NOTE

Irregular wear on gear teeth may be caused by worn bearings (13), worn pins (10), or worn bushings (18). Replace as required.

(6) Inspect the rollers (3, fig. 7-2) and lobes of actuating shaft (5) for wear. The minimum diameter of the rollers is 1.125 inches, and the minimum measurement (center to extreme lobe edge) on the actuating (cam) shaft is 1.875 inches. Replace either component if these minimum measurements are reached or exceeded.

(7) Inspect brake retainer and tension springs for cracks or other damage. Replace as required.

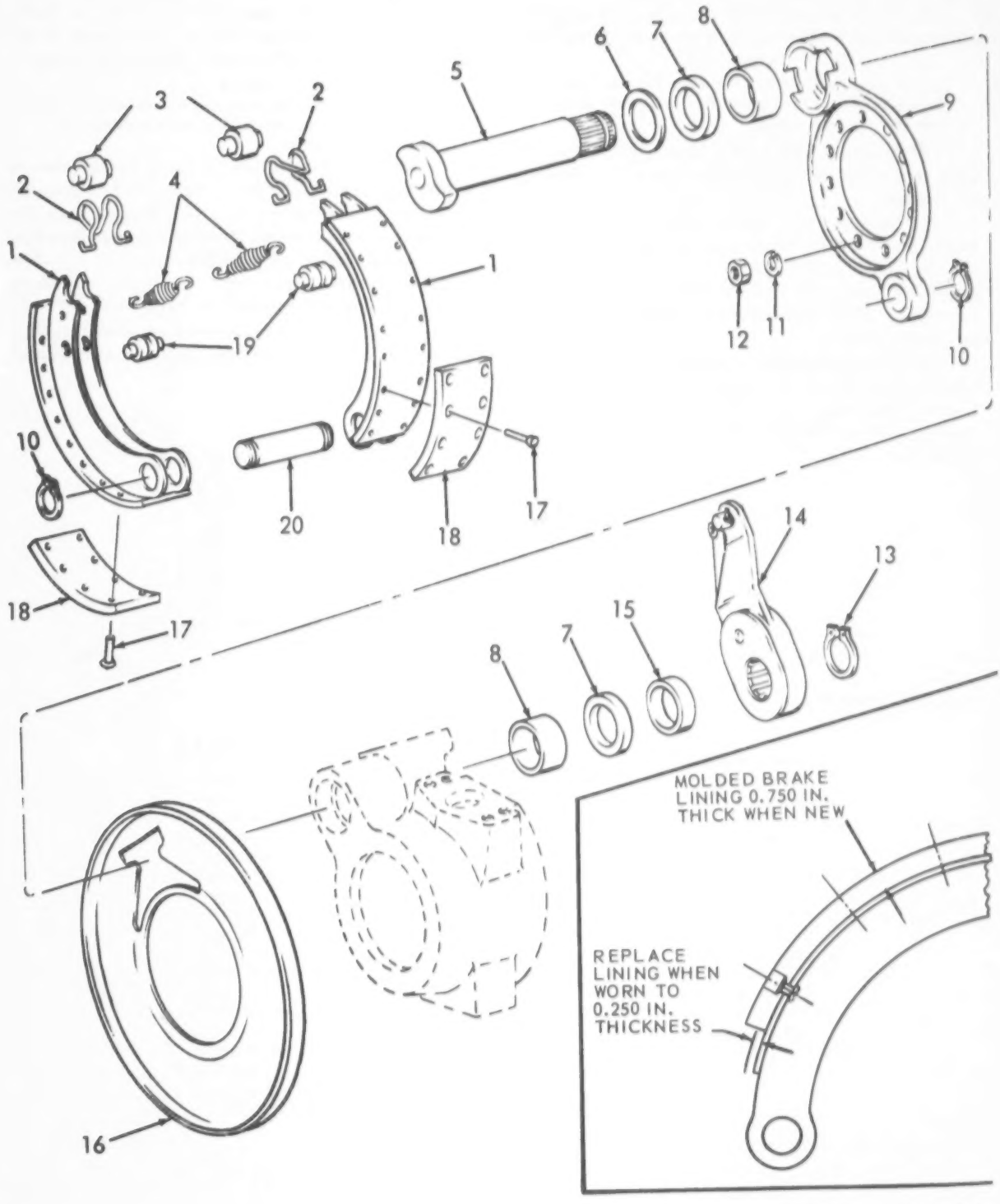


Figure 7-2. Brake assembly, exploded view.

Key to figure 7-2:

1 Brake shoe (2)
2 Spring (2)
3 Roller (2)
4 Spring (2)
5 Actuating shaft
6 Thrust washer
7 Seal (2)
8 Bushing (2)
9 Spider
10 Retaining ring (2)
11 Lockwasher (12)
12 Nut (12)
13 Retaining ring
14 Slack adjuster
15 Spacer
16 Dust shield
17 Rivet (32)
18 Lining (4)
19 Roller (2)
20 Anchor pin

d. Assembly.

(1) Assemble hub (28, fig. 7-1) and brake drum (24) using capscrews (22) and lockwashers (23).

(2) Replace dust shield (16, fig. 7-2) and spider (9) using lockwashers (11) and nuts (12).

(3) Install actuating shaft (5), bushing (8), seals (7), washer (6), spacer (15), slack adjuster (14), and retainer ring (13).

(4) Install anchor pin (20), brake shoes (1), retaining ring (10), rollers (3 and 19) and springs (2 and 4).

(5) Install the planetary gears (15, fig. 7-1), pins (10), and balls (11) in the spider (9).

e. Installation.

(1) Install the assembled hub (28) and brake drum (24).

(2) Install the ring gear (19).

(3) Install the skein locknut (17) and keys (16).

(4) Install the spider assembly (9) and secure with capscrews (32) and lockwashers (33). Torque to 100-110 ft. lbs. Replace the two capscrews (34).

(5) Install the thrust washer (8), "sun" gear (7), retainer ring (6), and thrust button (5).

(6) Install new gasket (4) and cover (3). Secure with capscrews (1) and lockwashers (2). Torque to 50-58 ft-lbs.

(7) Install the brake chamber (TM 5-3810-233-12).

(8) Install the wheel assembly (TM 5-3810-233-12).

(9) Install drain plugs (30) and service planetary housing in accordance with current lubrication order.

f. Adjustment. To properly adjust the wheel bearing after installing the skein locknut, use the following procedure:

(1) Attach a cord or wire to one of the studs on the outer circumference of the wheel hub.

(2) Wrap the cord or wire around the hub and make a loop in the free end; position free end at top of the wheel hub.

(3) Attach a spring scale in the loop of the wire or cord.

(4) Adjust the wheel bearing skein nut until a free roll is obtained, with a 15 to 20 lb. pull on the spring scale.

Section II. AXLE ASSEMBLY

7-3. General

a. The disassembly of the axle assembly will be facilitated by the removal of the assembly from the carrier chassis (para 2-10). Instructions are applicable to either the front or rear axle assembly.

b. Remove the wheel assemblies (TM 5-3810-233-12).

c. Place the assembly on a suitable stand and remove the hub and brake assemblies (para 7-2).

7-4. Axle Assembly

a. Removal and Disassembly.

(1) Remove plug (14, fig. 7-3) and drain lubricant from axle housing (11).

(2) Remove nuts (12, fig. 7-2) and lockwashers (11).

(3) Remove spider (9, fig. 7-2) and dust shield (16).

(4) Tap skein (1, fig. 7-3) with soft hammer and remove.

(5) Remove outer and inner axle assembly (3, 4, 5, and 6, fig. 7-3) from the axle housing (11).

(6) Remove cotter pins (45), nuts (46), and tie rod assembly.

NOTE

Disassembly is identical for each end except that steering arm (30) is replaced by cover on opposite end.

(7) Remove eight nuts (31), lockwashers (32), steering arm (30), tie rod arm (23), and shims (24).

(8) Remove capscrews (8), lockwashers (7), retainer connectors (9), seal retainers (10), and packing (42) from rear of socket (27).

(9) Remove the shouldered shafts (25) from the top and bottom of the socket (27) with suitable tool.

(10) Remove the socket from the ball (34). Remove the bearing cones (36).

(11) Remove nuts (44) and lockwashers (43). Remove the ball (34) from the axle housing (11).

(12) Remove the seal (41) from the rear of the ball. Remove the seal (40) from inside the ball. *Discard the seals (40 and 41) and packing (42).*

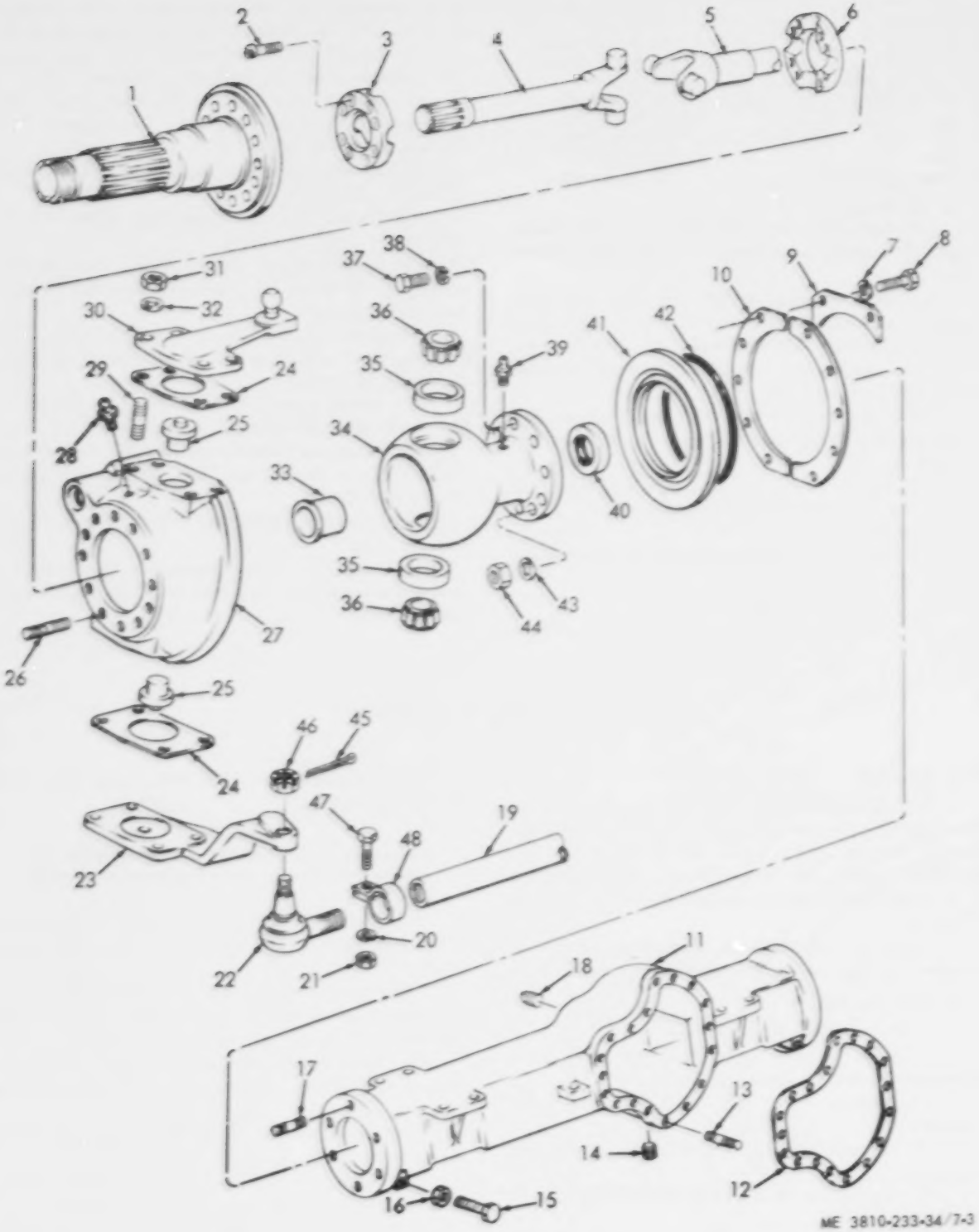


Figure 7-3. Axle housing, ball and socket assemblies, exploded view.

Key to figure 7-3:

1 Skein (2)
2 Screw (16)
3 Cage (2)
4 Outer axle (2)
5 Inner axle (2)
6 Cage (2)
7 Lockwasher (20)
8 Capscrew (20)
9 Retainer connector (4)
10 Seal retainer
11 Axle housing
12 Gasket
13 Stud
14 Magnetic plug
15 Capscrew (2)
16 Locknut (2)
17 Stud (16)
18 Plug
19 Tie rod
20 Lockwasher (2)
21 Nut (2)
22 Socket assembly (2)
23 Tie rod arm (2)
24 Shim (2)
25 Shouldered shaft (4)
26 Stud (24)
27 Socket (2)
28 Pressure relief fitting (2)
29 Stud (16)
30 Steering arm (opposite end replaced by cover)
31 Nut (16)
32 Lockwasher (16)
33 Bushing (2)
34 Ball (2)
35 Bearing cup (4)
36 Bearing cone (4)
37 Capscrew (2)
38 Lockwasher (2)
39 Lube fitting (4)
40 Seal (2)
41 Seal (2)
42 Packing (2)
43 Lockwasher (16)
44 Nut (16)
45 Cotter pin (2)
46 Slotted nut (2)
47 Capscrew (2)
48 Clamp (2)

b. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry with compressed air.

(2) Inspect the bearing cones (36) for worn or damaged roller. Inspect bearing cups (35) for wear or rough spots. Replace as required.

(3) Inspect shafts (25) for wear or scored areas. Replace as required.

(4) Inspect all studs and capscrews for worn or damaged threads. Replace as required.

(5) Inspect axle shaft assembly for play in cage (3). Torque cage screws (2) to 85-95 ft-lbs. End play between inner (5) and outer axle (4) should not exceed 0.006-0.008 inch. Radial (angular) play between axles should not exceed two degrees. Inspect splined ends of shafts for signs of wear or damaged teeth. Replace shafts and cages as required.

(6) Inspect interior of socket (27) for wear or signs of scoring, cracks, or damage. Replace as required.

(7) Inspect surface of ball (34) for scoring or rough spots. Inspect bushing (33) for scoring, wear, or signs of overheating. Replace as required.

NOTE

When replacing bushing (33) in ball (34), the inside bore is 2.393 inches when installed.

(8) Inspect tie rod socket assemblies (22) and arms (23) for wear. Replace as required.

c. Assembly.

(1) Install new seals (40) in ball (34). Install seal (41) on rear of ball.

(2) Install ball (34) on axle housing (11) and attach with nuts (44), capscrew (37), and lockwashers (38 and 43). Torque nuts and capscrew to 370-390 ft-lbs.

(3) Lubricate bearing cones (36), bearing cups (35), and install in balls (34).

(4) Install socket (27) on ball. Secure in place by pressing shouldered shafts (25) into the bearing cones (36).

(5) Position the seal (41) on the ball; install the packing (42) and secure with the seal retainers (10), retainer connectors (9), capscrews (8), and lockwashers (7). Torque capscrews to 15-20 ft-lbs.

(6) Install the shims (24), steering arm (30), and tie rod arm (23). Secure with the nuts (31) and lockwashers (32). Torque nuts to 290-300 ft-lbs.

(7) Install the tie rod assembly and secure with nuts (46) and cotter pins (45).

(8) Install the inner and outer axle shaft assembly in the axle housing (11).

(9) Install the axle skein (1, fig. 7-3), dust shield (16, fig. 7-2) and brake spider (9). Attach with nuts (12) and lockwashers (11). Torque nuts to 85-95 ft-lbs.

(10) Install the brake assemblies, wheel hub and brake drum, and planetary outer end assemblies (para 7-2).

d. Installation.

(1) Install the axle assembly on the carrier frame (para 2-14).

(2) Install the wheel assemblies (TM 5-3810-233-12).

(3) Service the planetary assemblies in accordance with the current lubricaton order.

e. Adjustment. The trunnion bearing are preloaded as described in paragraph 2-10.

Section III. DIFFERENTIAL CARRIER ASSEMBLY

7-5. General

Each axle houses a differential carrier assembly mounted in a case, and installed in the axle. The carrier assemblies are identical in design, and maintenance instructions are applicable to both front and rear axle assemblies. Each carrier assembly is connected to the transfer case through drive shafts equipped with universal joints.

7-6. Differential Carrier Assembly

a. Removal.

(1) Remove the axle assembly (para 7-4).

(2) Remove the 18 nuts (40, fig. 7-4) and lockwashers (39). Insert two capscrews in the threaded holes in the carrier case. Tighten the screws and remove the carrier assembly from the axle housing. Discard the gasket (12, fig. 7-3).

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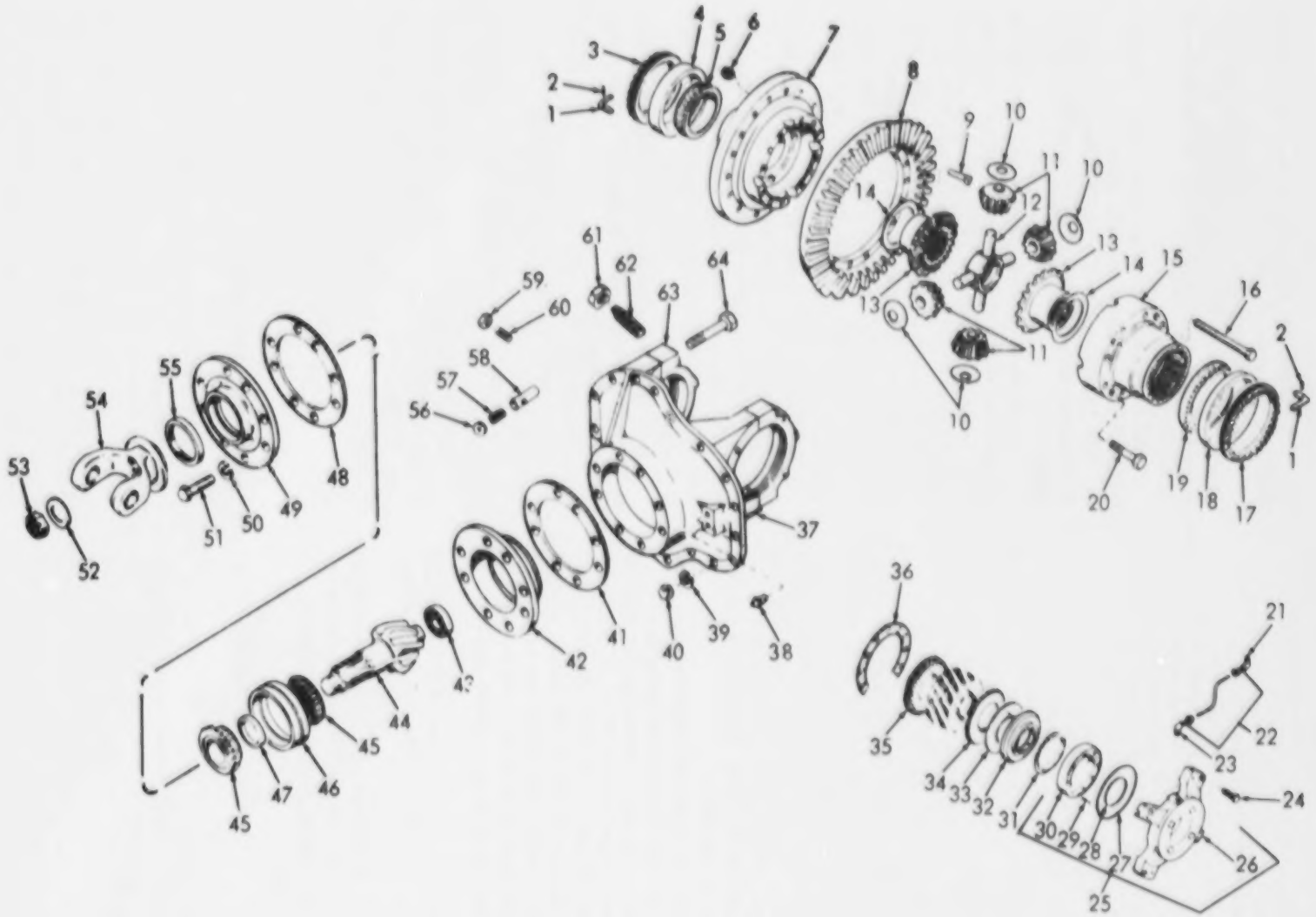


Figure 7-4. Carrier assembly components, exploded view.

Key to figure 7-4:

1 Lock (2)
2 Roll pin (2)
3 Locknut
4 Cup
5 Cone
6 Nut (8)
7 Differential case
8 Ring gear
9 Rivet (12)
10 Thrust washer (4)
11 Pinion gear (4)
12 Spider
13 Side gear (2)
14 Thrust washer (2)
15 Differential case
16 Bolt (8)
17 Brg. locknut
18 Cup
19 Cone
20 Capscrew (4)
21 Connector
22 Tube assembly
23 Elbow
24 Capscrew (4)
25 Piston assembly
26 Housing
27 Preformed packing
28 Preformed packing
29 Pin
30 Piston
31 Thrust bearing
32 Lockout spacer
33 Friction disc
34 Opposing disc
35 Spacer
36 Shim
37 Carrier housing
38 Bleed fitting
39 Lockwasher (18)
40 Nut (18)
41 Shim pack
42 Housing
43 Pilot bearing
44 Pinion gear shaft
45 Cone (2)
46 Cup
47 Spacer
48 Gasket
49 Retainer
50 Lockwasher (8)
51 Capscrew (8)
52 Washer
53 Nut
54 Yoke
55 Seal
56 Plug
57 Spring
58 Oil scoop
59 Nut
60 Setscrew
61 Nut
62 Back-up plug
63 Bearing cap (2)
64 Capscrew (4)

b. Disassembly.

(1) Remove two hydraulic lines (22, fig. 7-4) from the piston housing (26) and carrier housing (37).

(2) Remove the safety wire and four capscrews (24) that attach the housing (26) to the carrier assembly. Remove the housing, shims (36), piston (30) and preformed packings (27 and 28).

(3) Remove the thrust bearing (31), lockout spacer (32), tractionlock discs (33 and 34), and inner spacer (35).

(4) Remove the two roll pins (2), locks (1), safety wire, and capscrews (64) that secure bearing caps (63) and locknuts (3 and 17). Remove bearing caps and locknuts. Remove the differential assembly from the carrier.

(5) Remove the safety wire and four capscrews (20) from the differential case (15).

(6) Remove the eight elastic stop nuts (6) and through bolts (16). Separate the two halves of the differential case (7 and 15).

(7) Remove the bearing cups (4 and 18), and bearing cones (5 and 19).

(8) Remove the four thrust washers (10), spider gears (4), spider (12), two side gears (13), and thrust washers (14).

(9) The ring gear (8) may be riveted to the differential case (7). If the gear requires replacing, use capscrews and elastic stop nuts to secure the gear to the case. The ring gear (8) and pinion (44) are matched items and must be installed as a set.

CAUTION

Remove rivets by drilling out heads with suitable size drill and removing rivets with a tapered drift. Never use a chisel to remove rivet heads.

NOTE

When capscrews ½-20 UNF x 2¼ and stop nuts are used in lieu of rivets, the case (7) must be spot faced on its outer side to provide clearance for the nuts. Spot face to a diameter of 1.00 inches and to a depth to provide a dimension of 0.88 inches from face of spot face to the surface mating with the ring gear. Torque the stop nuts to 70-80 ft-lbs. when assembling.

(10) Remove the nut (53), washer (52), and yoke (54) from the pinion shaft (44).

(11) Remove the capscrews (51), lockwashers (50), bearing retainer (49), seal (55), and gasket (48). Discard seal (55) and gasket (48).

(12) Two capscrews may be inserted in the two threaded holes provided in bearing housing (42) to act as a puller. Remove bearing housing from carrier housing (37). Remove shim pack (41).

(13) Remove outer bearing cone (45) and spacer (47).

(14) With suitable pullers or presses remove inner bearing cone (45) and pilot bearing (43) from pinion shaft (44) and remove the bearing cup (46) from bearing housing (42).

(15) Remove the nut (59), setscrew (60), plug (56), spring (57), oil scoop (58), nut (61), back-up plug (62), and bleeder fitting (38).

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly with compressed air.

(2) Inspect gears, pinion shaft, thrust washers, and bearing cups for scoring or excessive wear.

(3) Place bearing cones in their respective cups and rotate by hand to detect roughness or excessive play.

(4) Inspect the tractionlock fiber-faced discs and friction discs for scoring and wearing of fiber facing.

d. Assembly.

(1) Insta.: pilot bearing (43) and inner bearing cone (45) on shaft (44), and bearing cup (46) into bearing housing (42) with a suitable press.

(2) Install bearing housing (42) with bearing cup (46), spacer (47), outer bearing (45), yoke (54), washer (52), and nut (53) onto the pinion shaft (44). Torque nut (53) to 350-450 ft-lbs.

(3) Check the preload on the pinion bearing by securing the bearing housing in a vise, wrapping a stout cord around the neck of the yoke (54), and attaching a spring scale to the free end of the cord. The breakaway force required to rotate the shaft as indicated on the scale should read between 4-11 pounds (5-15 inch pounds). If the reading on the scale is less than 4 pounds, the spacer (47) is too thick; if the reading is greater than 11 pounds, the spacer must be replaced by a thicker spacer. Grind a thick spacer or replace a thin spacer as required to obtain desired reading.

(4) Remove the nut (53), washer (52), and yoke (54) to install a new gasket (48), new seal (55), and bearing retainer (49). Reinstall the nut, washers, and yoke on the shaft. Torque nut to 350-450 ft-lbs.

(5) Install the pinion gear assembly into the carrier housing using shim pack (41), capscrews (51), and lockwashers (50). Torque capscrews to 135-145 ft-lbs.

(6) If ring gear (8) or differential case (7) are replaced, assemble them as directed in paragraph 7-6.

(7) Lubricate the spider (12). Install the four pinion gears (11) and thrust washers (10) on the spider.

(8) Install the thrust washers (14) and side gears (13) in the two halves of the differential case (7 and 15).

(9) Install the spider assembly in the ring gear side of the differential case (7). Place the two halves of the differential case together and secure with the eight bolts (16), stop nuts (6), and four capscrews (20). Torque the nuts to 100-110 ft-lbs. and the four capscrews to 70-80 ft-lbs. Safety wire the four capscrews.

CAUTION

Elastic stop nuts are normally good for more than "one-time" usage but may require replacement during assembly.

(10) Install the bearing cones (5 and 19), and cups (4 and 18) on the differential case.

(11) Position the differential assembly on the carrier housing (37), and install bearing caps (63), bolts (64), and locknuts (3 and 17). Tighten bearing cap bolts and adjust locknuts to provide 0.030-0.035 inch backlash between ring gear and pinion.

(12) Remove pinion gear assembly to provide clearance for checking preloading of differential case bearings. Measure preload as described in paragraph 7-6. Tighten locknuts (3 and 17) equally to provide a preload of 25-50 ft-lbs. torque. Reinstall pinion gear assembly, paragraph (5) above.

(13) Establish final backlash of 0.010-0.013 inches for new gears, 0.030-0.035 inches permissible for used gears, by adjusting locknuts (3 and 17) equally to maintain preload.

(14) Position locks (1) and secure with roll pins (2). Torque bearing cap bolts (64) to 240-250 ft-lbs.

(15) Install back-up plug (62) until contact is made with ring gear and secure with nut (61).

(16) Install oil scoop (58), spring (57), and plug (56) in differential case. Place 0.010 shim between oil scoop and ring gear, secure oil scoop with setscrew (60) and nut (59). Remove shim.

(17) Install the tractionlock system in the differential case (15). Insert the inner spacer (35), a friction disc (33) and an opposing disc (34) until the disc assembly has been replaced.

NOTE

The discs in the set (12 of each type) are not issued as an assembly.

(18) Install new packing (27 and 28) in the grooves in the housing (26) after making sure that there are no burrs or sharp edges in the packing grooves. Lubricate the packing with clean hydraulic brake fluid and install the piston (30) in the housing (26).

NOTE

The piston (30) has a small dowel or pin which must enter the dowel pin hole in the spider bore. Mark the location of the dowel hole on the spider to facilitate inserting the piston.

(19) Install bearing (31) on the outer spacer (32) and install spacer on discs with bearing facing outward. Place the shims (36) on the differential case (15) and install piston and housing assembly (25). Secure the housing to the differential with four capscrews (24). Measure the clearance between thrust bearing (31) and piston (30). Clearance should be not less than 0.030 inch and not more than 0.050 inch. Add or remove shims (36) to obtain correct clearance.

(20) Install bleeder fitting (38).

(21) Test the system for leaks by connecting a line from the tractionlock system to the tractionlock system in the carrier. Maximum pressure should not exceed 1200 psi and minimum pressure should be 650 pounds per square inch, and the carrier assembly pressure should remain constant for 15 minutes.

(22) Safety wire all capscrews and install the two hydraulic lines (22).

e. Installation.

(1) Install the carrier assembly in the axle housing, and secure with nuts (40) and lockwashers (39). Use a new gasket (12, fig. 7-3). Torque nuts to 60 ft-lbs.

(2) Install the axle assembly (para 7-4).

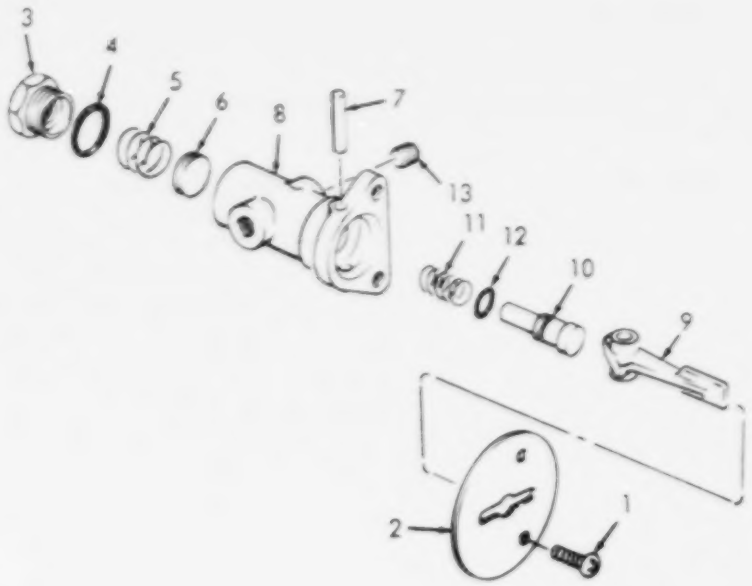
7-7. Traction Lockout and / or Rear Lock Valve Assembly

a. Removal.

(1) Disconnect the two air lines from the valve assembly.

(2) Remove two machine screws (1, fig. 7-5) and dial (2) from the valve assembly.

(3) Remove valve assembly from the rear of the instrument panel.



ME 3810-233-34/7-5

1 Screw
2 Dial
3 Spring retainer nut
4 Preformed packing
5 Spring
6 Valve
7 Pin
8 Body
9 Lever
10 Plunger
11 Spring
12 Grommet
13 Pipe plug

Figure 7-5. Traction lockout and rear lockout valve, exploded view.

b. Disassembly.

(1) Remove spring retainer (3) and discard preformed packing (4).

(2) Remove spring (5) and valve (6) from valve body (8).

(3) Press pin (7) from body (8) and cam lever (9).

(4) Remove lever (9), plunger (10), and spring (11) from body.

(5) Discard preformed packing (12).

(6) Remove pipe plug (13).

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent. Dry thoroughly with compressed air.

(2) Check mating surfaces of plunger (10) and valve (6) for scoring. Minor scoring can be removed by lapping with a fine stone or crocus paper.

(3) Check cam surfaces of lever (9) and head of plunger for excessive wear.

(4) Replace any damaged or badly worn parts.

d. Assembly.

(1) Replace preformed packings (4 and 12).

(2) Lightly lubricate the valve (5), plunger (10), and cam of lever (40) before assembly.

(3) Assemble valve in reverse of instructions in paragraph *b* above.

(4) Check to be sure springs are properly seated and functioning correctly.

e. Installation. Install valve assembly by reversing the instructions of paragraph *a* above.

CHAPTER 8

REPAIR OF STEERING SYSTEM

Section I. FRONT STEERING

8-1. General

The front wheel steering is provided by a mechanical cam-and-lever unit controlled by the steering wheel and connected to a power steering control valve and drag link assembly. The control valve regulates the hydraulic fluid to a hydraulic steering cylinder which provides the larger portion of turning torque required for steering. Hydraulic power for the front wheel steering is obtained from the crane hydraulic system (fig. 1-7).

8-2. Front Steering Control Valve

a. Removal.

Refer to TM 5-3810-233-12, to remove the front steering control valve.

b. Disassembly.

(1) Remove lube fittings (12, fig. 8-1) from valve housing (11) and drag link (18).

(2) If not completely removed upon removal of the unit, remove the socket plug (4), plug washer (5), spring (6), and both ball sockets (7) from the valve socket assembly.

(3) In the same manner remove the end plug (33), spacer (32), spring (31), both ball sockets (30), and the seat (29) from the drag link.

(4) Loosen bolt (19) and clamp (20) to permit separation of the drag link (18) and the valve assembly.

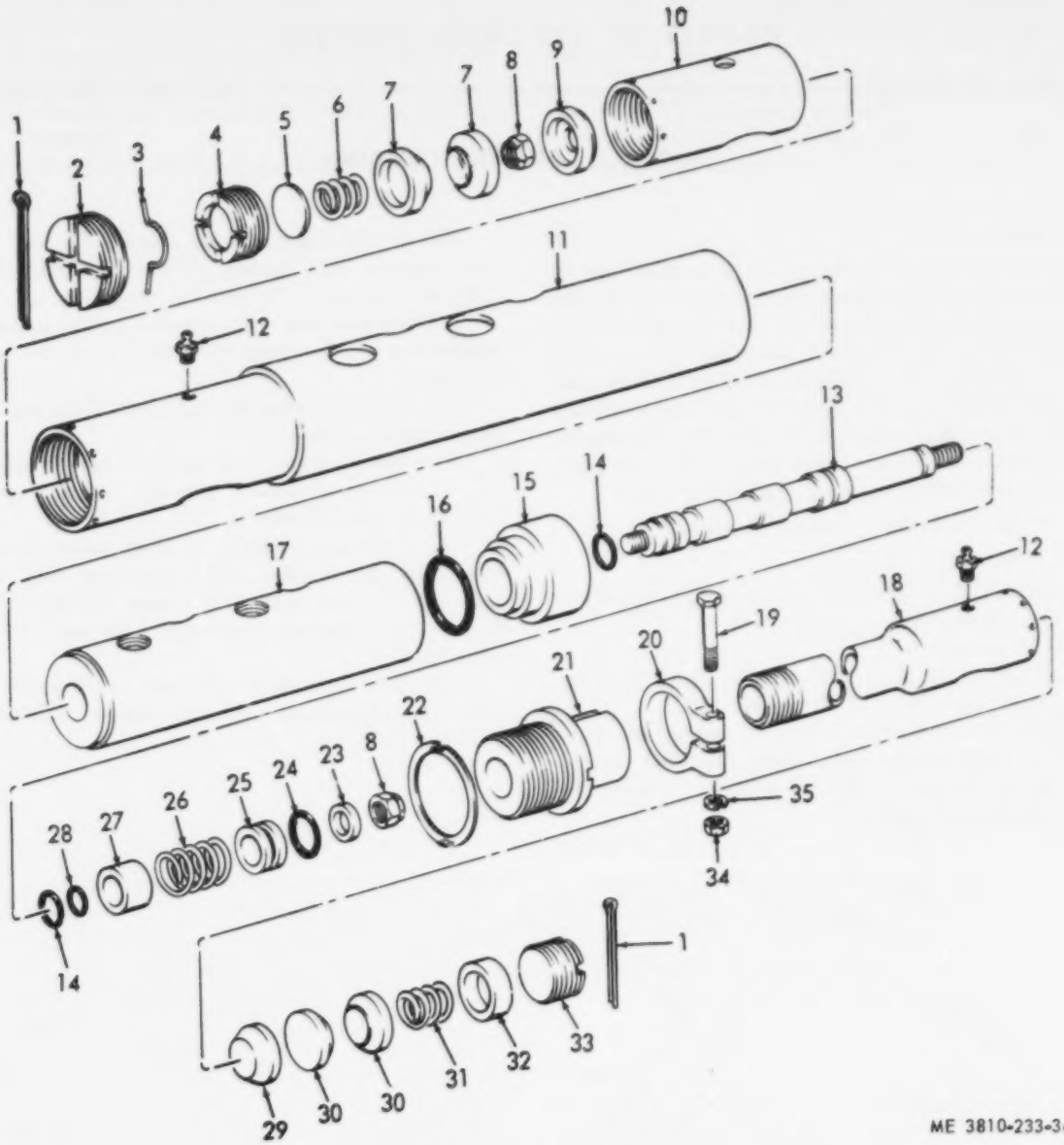
(5) Remove adapter (21) and lockring (22) from valve housing (11).

(6) Remove two locknuts (8) spool ends.

(7) Remove socket bearing (9) and socket (10) from valve body.

(8) Pull spool assembly from valve housing, removing the washer (23), reaction ring (25), spring, (26), and spacer (27) from the spool (13). Remove and discard preformed packings (14, 24, and 28).

(9) Lift the gland (15) and valve body (17) from valve housings (11), and discard preformed packing (16).



1 Cotter pin
2 End plug
3 Plug lock
4 Ball socket plug
5 Plug washer
6 Spring
7 Ball seat
8 Locknut
9 Ball socket bearing
10 Ball socket
11 Valve housing
12 Lube fitting
13 Spool
14 Preformed packing
15 Gland
16 Preformed packing
17 Valve body
18 Drag link
19 Capscrew
20 Clamp
21 Adapter
22 Lockring
23 Washer
24 Preformed packing
25 Reaction ring
26 Spring
27 Spacer
28 Preformed packing
29 Seat
30 Ball seat
31 Spring
32 Spacer
33 End plug
34 Nut
35 Lockwasher

Figure 8-1. Front steering control valve and drag link assembly, exploded view.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly with compressed air.

(2) Inspect all parts for wear, cracks, scoring, or other signs of damage.

(3) Replace any part that shows signs of wear or other damage.

NOTE

The spool (13) and valve body (17) must be replaced as a matched set.

d. Assembly.

(1) Assembly is essentially the reverse of paragraph *b* above, with the following special instructions.

(2) Replace all packings and install a new lockring (22).

(3) Lightly lubricate all parts with hydraulic fluid before assembly, to ease assembly and provide better seals at packings.

(4) Torque the locknuts (8) to 80-90 foot pounds.

e. Installation. Install the front steering control valve and drag link as instructed in TM 5-3810-233-12.

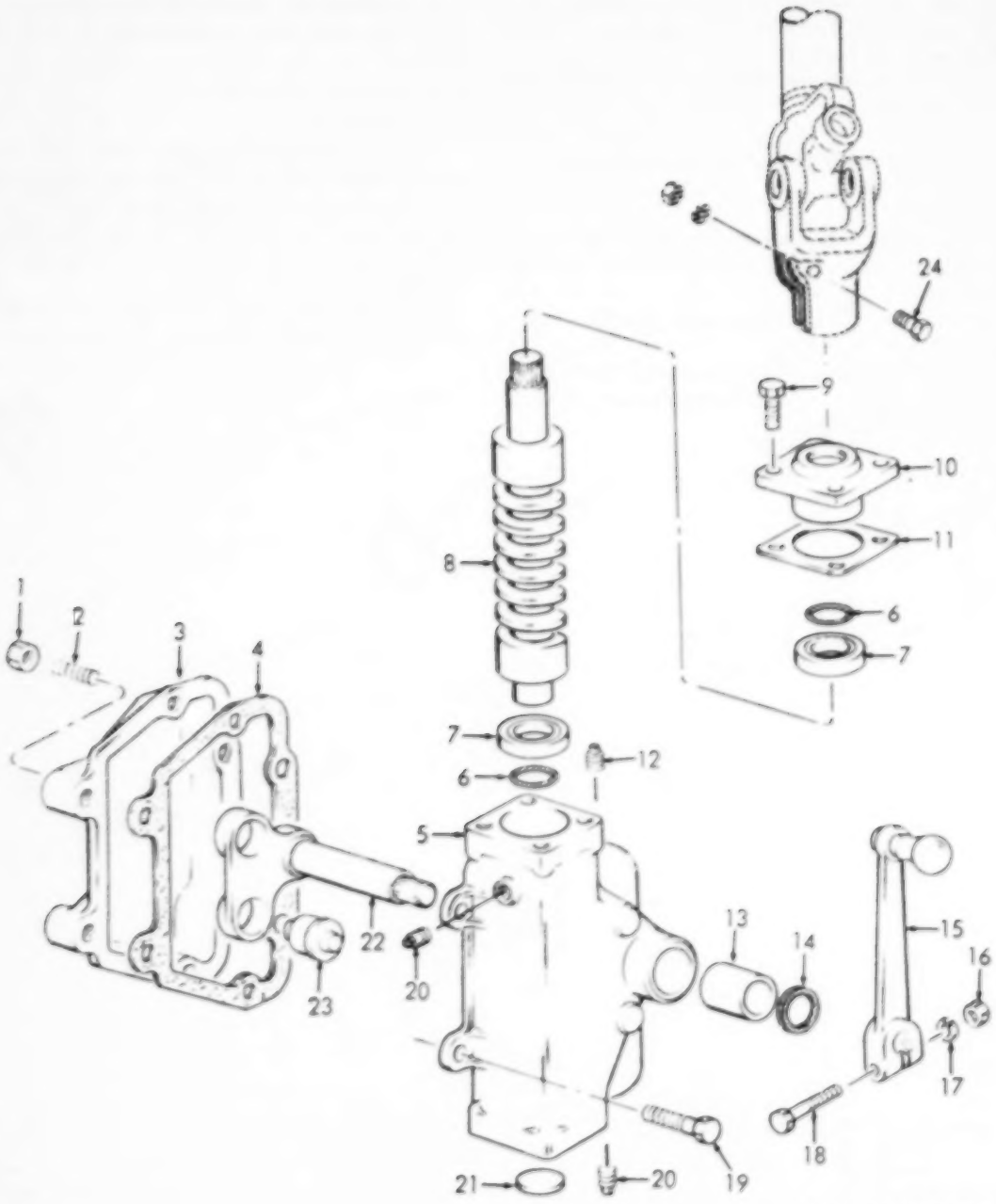
8-3. Steering Gear Box

a. Removal.

(1) Loosen the clamping screw (24, fig. 8-2) on the bottom yoke of the universal shaft assembly.

(2) Remove the cotter pin (1, fig. 8-1), remove the end plug (2) and plug lock (3). Loosen the ball socket plug (4) and remove the control valve from the ball stud of the steering arm.

(3) Remove three nuts that secure the gear box to the bracket. Remove the gear box.



1 Locknut
2 Setscrew
3 Cover
4 Gasket
5 Housing
6 Seal
7 Bearing
8 Cam
9 Capscrew
10 Cover assy
11 Shim
12 Plug
13 Bushing
14 Seal
15 Steering arm
16 Nut
17 Lockwasher
18 Capscrew
19 Capscrew
20 Plug
21 Expansion plug
22 Shaft
23 Bearing assy
24 Screw

Figure 8-2. Steering gear box, exploded view.

b. Disassembly.

NOTE

Before disassembly, match mark the steering arm and shaft so they may be assembled the same way.

(1) Remove the nut (16, fig. 8-2), lockwasher (17), capscrew (18) and steering arm (15).

(2) Remove plugs (12 and 20) and drain lubricant.

(3) Remove locknut (1) and setscrew (2).

(4) Remove four capscrews (19), remove the cover (3) and gasket (4).

(5) Remove the assembled shaft (22) and bearing assemblies (23). Press the bearing assemblies from the shaft only if replacement is necessary.

(6) Remove the four capscrews (9), the cover assembly (10) and the shims (11).

(7) Lift out cam (8), remove seals (6) and bearings (7).

(8) Press the seal (14) from the housing (5). Remove the bushing (13) only if replacement is necessary.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Inspect shaft (22) for scoring or signs of wear. Remove minor scoring with fine crocus cloth. Insert the shaft in the housing and check for excessive play between the shaft and the bushing (13). Replace bushing if scored or if worn to allow 0.0350 total radial clearance.

(3) Inspect the bearing assemblies (23) for snug fit in shaft and smooth operation. Inspect cam follower tips of bearing assemblies and cam (8) for crack and signs of wear. Replace parts as required.

(4) Inspect the bearings (7) pitting and binding. Check operation by the rotating bearing by hand. Replace a bearing that does not operate smoothly or is pitted.

(5) Inspect the housing and the covers for cracks or damaged threads. Replace as required.

d. Assembly. Assemble the steering gear box by reversing the instructions of paragraph *b* above.

e. Installation. Install the steering gear box by reversing the instructions of paragraph *c* above.

f. Adjustment.

(1) Loosen locknut (1) and turn setscrew (2) in until a noticeable drag is produced on the steering wheel.

(2) Back off the setscrew ½ turn and secure in place with locknut.

NOTE

After considerable vehicle usage, readjustment may be necessary to compensate for wear of cam and follower which may be detected by play in the steering wheel.

8-4. Hydraulic Steering Cylinder

a. Removal. Remove hydraulic steering cylinder as instructed in TM 5-3810-233-12.

b. Disassembly.

(1) Loosen capscrew (25, fig. 8-3) and remove ball stud and socket assembly from operating rod (18).

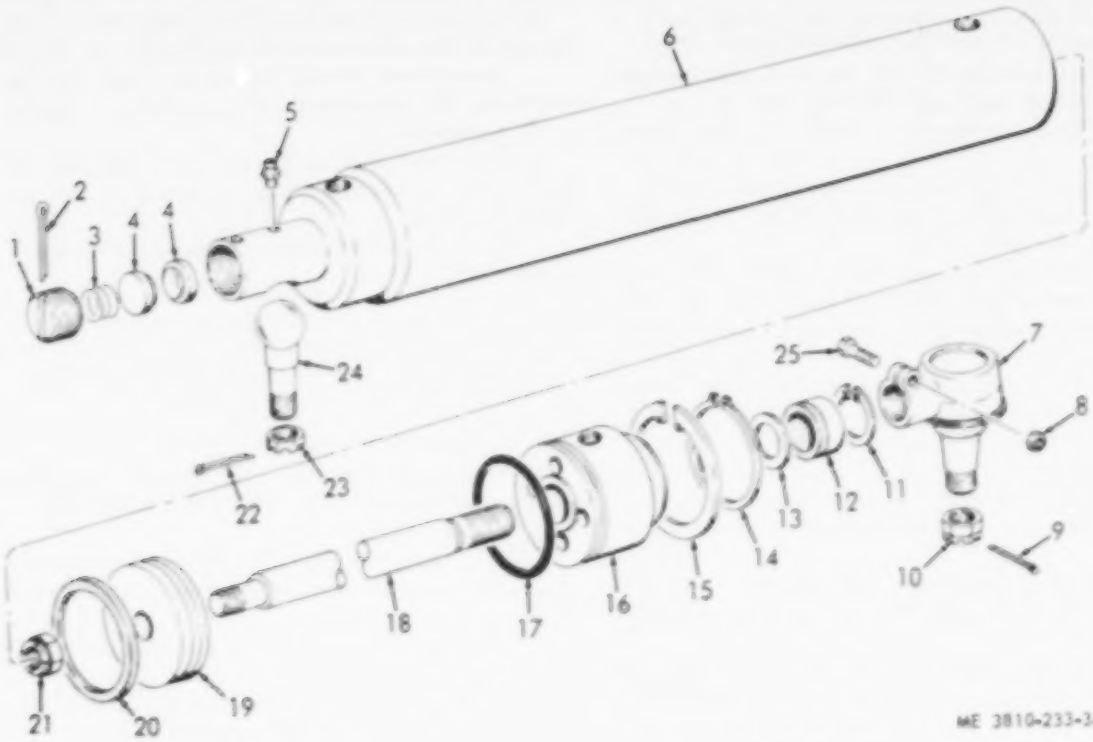
(2) Remove cotter pin (2) that locks end plug (1) in place.

(3) Remove end plug (1), spring (3), ball stud (24), and ball seats (4) from cylinder body (6).

(4) Remove retainer rings (14 and 15) and pull piston-rod and head assemblies from cylinder body (6). Slide head assembly from rod.

(5) Remove retainer ring (11) and remove seal (12), washer (13), and packing (17) from head (16).

(6) Remove nut (21) and separate piston (19) and rod (18). Remove and discard packing (17) from piston.



1 Plug
2 Cotter pin
3 Spring
4 Seat
5 Lubrication fitting
6 Body
7 Ball stud and socket assembly
8 Nut
9 Cotter pin
10 Nut
11 Retainer ring
12 Seal
13 Washer
14 Retainer ring
15 Retainer ring
16 Head
17 Packing
18 Rod
19 Piston
20 Ring
21 Nut
22 Cotter pin
23 Nut
24 Ball stud
25 Screw

Figure 8-3. Hydraulic steering cylinder, exploded view.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly with compressed air.

(2) Inspect ball stud (24) and ball seats (4) for scoring or pitting. Replace parts that are pitted or badly scored.

(3) Inspect bore of head (16) and rod (18) for scoring, scratches, out-of-roundness, and other damage. Replace a badly worn or damaged rod and head. Light scoring can be removed with fine crocus paper.

(4) Inspect piston (19) for scoring, pitting and other damage. Remove any burrs and break sharp edges found. Replacement of the piston is necessary only if scoring or pitting is excessive.

(5) Inspect the bore of the cylinder body (6). Replace the body if it is found to be out-of-round, scored or damaged in any way.

d. Assembly.

(1) Assemble the hydraulic steering cylinder in reverse order of disassembly (para *b* above).

(2) Use new ring (20), packing (17), and seal (12) when assembling cylinder.

(3) When installing the end plug (1), tighten the plug down solidly, then back off ¼—½ turn to aline slot in plug with holes in body for cotter pin (2).

(4) Check alinement of threaded port in head (16) to hole provided in body (6).

e. Installation. Install the hydraulic steering cylinder as instructed in TM 5-3810-233-12.

Section II. REAR STEERING

8-5. General

The rear wheel steering is fully hydraulic with the power supplied by an engine-mounted pump (para 3-74). Control of the steering is effected by an instrument panel-mounted rear steer control valve (para 8-6), while the steering power is supplied by a hydraulic steering cylinder, identical in design and mounting the steering cylinder described in paragraph 8-4. A mechanical, air-operated locking device locks the rear axle in its normal position when rear steering is not required (TM 5-3510-233-12).

8-6. Rear Steer Control Valve

a. Removal. Remove the rear steering control valve from the instrument panel (TM 5-3810-233-12).

b. Disassembly.

(1) Remove two cotter pins (1, fig. 8-4) and remove pins (3) and lever (4). If necessary remove knob (5) from the lever.

(2) Remove two cotter pins (1) that secure pin (2) and the connecting link (6) to the valve body.

(3) Remove acorn nut (24), washers (25), and nut (26) from adjusting screw (27).

(4) Turn the adjusting screw out of the valve body and remove spring (28) and valve (29).

(5) Remove two socket head screws (20) that secure cover (21) to valve body. Remove and discard gasket (22).

(6) Pull spool assembly from bottom of valve body.

Key to figure 8-4:

1 Cotter pin
2 Pin
3 Yoke pin
4 Lever
5 Knob
6 Link
7 Preformed packing
8 Nut
9 Lockwasher
10 Housing
11 Pipe plug
12 Spring
13 Ball
14 Valve seat
15 Retainer
16 Spacer
17 Return spring
18 Spring guide
19 Guide retainer
20 Capscrew
21 Valve cap
22 Gasket
23 Valve spool
24 Cap nut
25 Gasket
26 Nut
27 Adjusting screw
28 Spring
29 Valve poppet
30 Pipe plug
31 Bolt

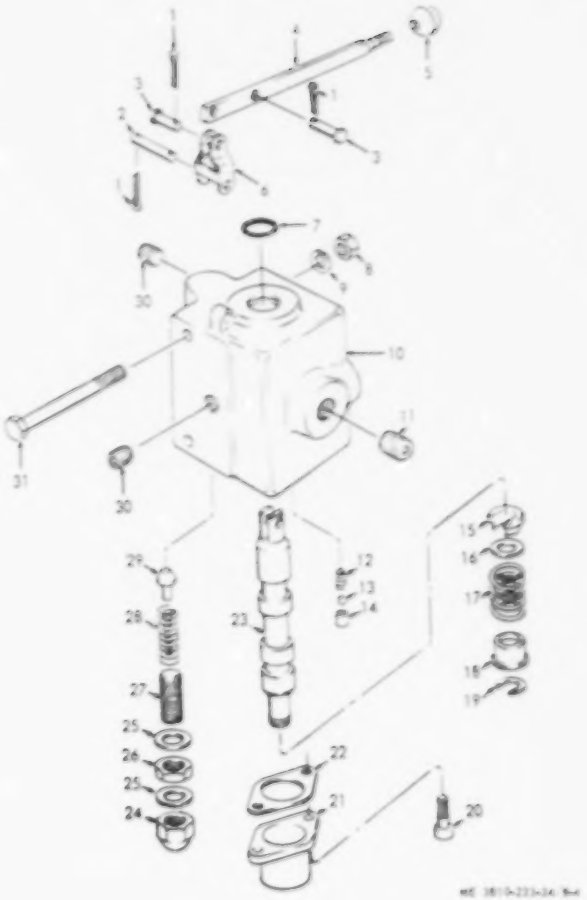


Figure 8-4. Rear steering control valve, exploded view.

CAUTION

In handling the spool (23), care must be exercised so that the spool is not scratched or damaged in any way.

(7) Depress spring guide (18) sufficiently enough to remove retainer (19) from spool. Remove guide (18), spring (17), washer (16), and retainer (15) from spool (23).

(8) Apply a source of air pressure (3 psi) to ball check valve assembly in valve body. If ball unseats at less than 3 psi, remove seat (14), ball (13), and spring (12).

(9) Remove and discard preformed packing (7).

(10) Remove pipe plugs (11 and 30) as necessary to facilitate cleaning.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts in an approved cleaning solvent and dry with compressed air.

(2) Inspect all parts for wear, scratches, cracks, or other damage. Replace worn or damaged parts.

(3) Check springs (17 and 28) by compressing between thumb and forefinger. Replace a spring that compresses to less than 2/3 of its free length.

d. Assembly. Assemble the rear steering control valve in reverse of instructions of paragraph *b* above, using new packing (7) and gasket (22).

NOTE

Set relief valve at 125 psi and lock with nut (26).

e. Installation. Install the rear steering control valve as instructed in TM 5-3810-233-12.

CHAPTER 9

REPAIR OF CAB AND BODY COMPONENTS

Section I. OPERATOR'S CAB

9-1. Frame and Windows

a. Removal. Remove the operator's cab (TM 5-3810-233-12).

b. Disassembly.

(1) Remove the windshield wiper assembly (TM 5-3810-233-12).

(2) Remove the cab dome light (TM 5-3810-233-12).

(3) Insert a screwdriver between the weather strip (1, fig. 9-1) and the cab and release the front window (2). Push the front window out from inside the cab.

(4) Remove the lower front glass (15), the two side panels (11), the side window (3) and the door window (7) in the same manner.

(5) Remove three hinge pins and remove the cab door.

(6) Remove nine screws that secure the rear window frame and remove the two rear windows (6).

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Figure 9-1. Operator's cab, exploded view.

Key to figure 9-1:

1 Weather strip
2 Glass, front window
3 Glass, side window
4 Cab
5 Channel
6 Glass, rear window
7 Glass, door window
8 Weather strip
9 Screw
10 Clip
11 Glass, side panel
12 Spring
13 Latch
14 Screw
15 Glass, front lower

c. Cleaning, Inspection, and Repair.

(1) Clean metal parts with a cloth dampened with cleaning solvent and dry thoroughly.

(2) Inspect metal parts for broken welds, cracks, dents, and worn or rusted spots. Repair broken welds, cracks, and dents where possible. Sand worn and rusted spots and repaint.

(3) Replace cracked or broken windows and other parts that are badly damaged.

d. Assembly. Assemble the operator's cab in reverse order of disassembly.

e. Installation. Install the operator's cab (TM 5-3810-233-12).

9-2. Operator's Seat

a. Removal. Remove the operator's seat (TM 5-3810-233-12).

b. Disassembly.

(1) Wedge a wood shim under the tube on the lever assembly (2, fig. 9-2) located beneath the front of the seat cushion.

(2) Remove the preload on the torsion bar by rotating the adjuster lever (30) counter-clockwise until the adjuster lever is disengaged from the seat.

(3) Remove the back cushion (46), by removing four capscrews (42) and lockwashers (39).

(4) Remove the four nuts (40) and eight washers (38 and 39) that secure the seat cushion (44). Move seat cushion forward to free nylon rollers (37). Remove the seat cushion.

(5) Remove right hand side panel assembly (29) by tapping out sideways. This allows yoke (26) to drop free.

(6) Remove the torsion bar (27) from the tube.

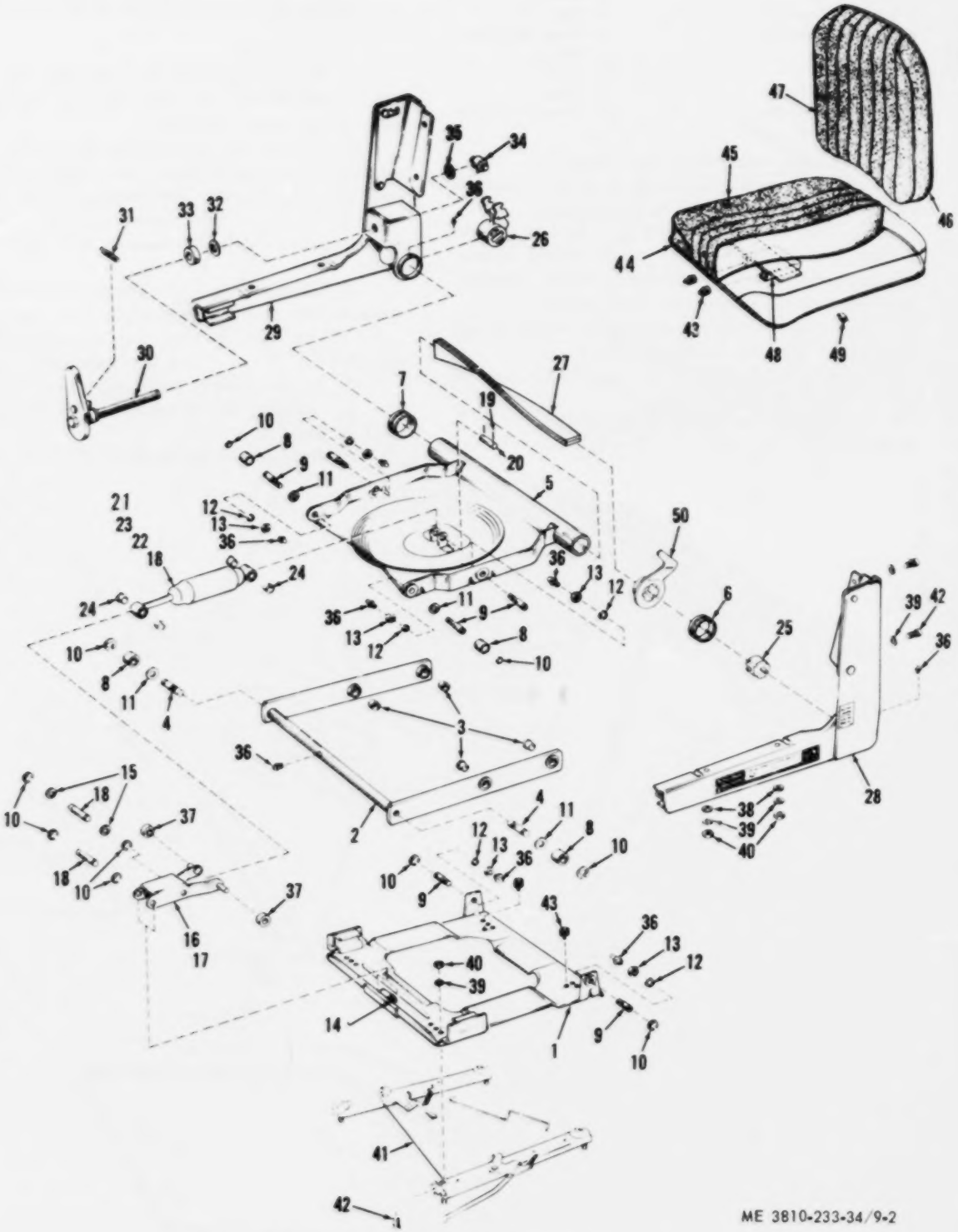


Figure 9-2. Operator's seat assembly, exploded view.

Key to figure 9-2:

1 Base assembly
2 Outer lever
3 Bearing
4 Pin
5 Center lever
6 Bearing, LH
7 Bearing, RH
8 Roller and bearing assy.
9 Stud
10 Snap ring
11 Washer
12 Lockwasher
13 Nut
14 Bearing
15 Washer
16 Shock lever assy
17 Shock lever
18 Hinge shaft
19 Hinge shaft, rear
20 Roll pin
21 Shock absorber
22 Shock absorber assy
23 Bearing kit
24 Bearing
25 Retainer
26 Yoke
27 Torsion bar
28 Side panel assy, LH
29 Side panel assy, RH
30 Adjuster screw and lever assy
31 Spring
32 Washer
33 Bearing
34 Pin
35 Washer
36 Lube fitting
37 Roller, nylon
38 Washer
39 Lockwasher
40 Nut
41 Adjuster assembly
42 Capscrew
43 Bumper
44 Seat cushion
45 Cover
46 Back cushion
47 Cover
48 Universal riser
49 Clip
50 Indicator

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent and dry thoroughly.

(2) Inspect all parts for cracks, breaks, or other damage. Repair or replace defective parts.

d. Assembly.

(1) Insert the torsion bar (27) in the tube being sure that the bars are engaged in the retainer (25) inside the tube at the left hand side of the seat.

(2) Replace the right hand side panel (29) with the yoke (26) held in position inside the housing on the side panel. Engage the yoke (26) on the free end of the torsion bar (27).

(3) Line up the side panels left hand (28) and right hand (29) retaining a 20" outside dimension between these panels.

(4) Install the seat cushion (44) moving it from the front of the seat toward the rear in order to engage the nylon rollers (37) properly in the housing under the seat cushion.

(5) Install the back cushion (46) and secure with four capscrews (42) and lockwashers (39).

(6) Install washer (32), bearing (33), pin (34), washer (35), and fitting (36) in their proper positions. Engage the yoke's (26) hooked ends over the lugs on the adjuster pin (34).

(7) Preload the torsion bars by rotating the lever assembly (30) clockwise.

e. Installation. Install the operator's seat (TM 5-3810-233-12).

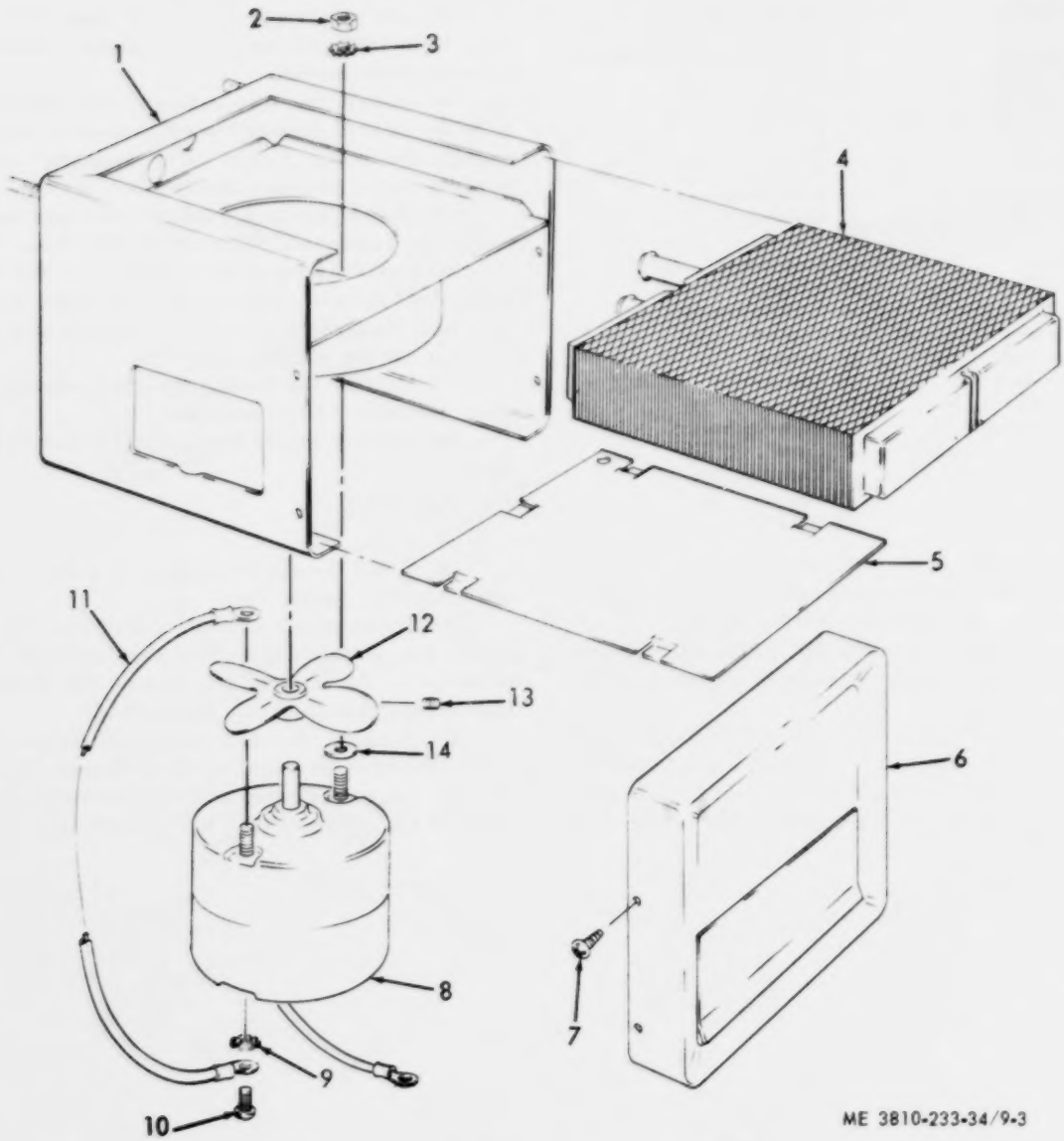
9-3. Cab Heater

a. Removal.

(1) Drain the cooling system to a level which will drain the heater core.

(2) Disconnect the electrical lead (11, fig. 9-3) to the fan motor. Disconnect the two hose connections to the heater. Disconnect the defroster hose connection from the heater body.

(3) Remove the four nuts and screws that secure the fresh air inlet box to the heater. Remove the three nuts and washers from the studs on the heater body. Remove the heater assembly.



1 Shell
2 Nut (2)
3 Lockwasher (2)
4 Core
5 Bottom plate
6 Cover
7 Screw (4)
8 Motor
9 Lockwasher
10 Screw
11 Lead
12 Fan
13 Setscrew
14 Flatwasher

Figure 9-3. Cab heater assembly, exploded view.

b. Disassembly.

(1) Remove the four screws (7) on the sides of the front panel (6) and remove the panel.

(2) Remove the core assembly (4).

(3) Remove the two nuts (2), lockwashers (3), and motor assembly (8).

c. Cleaning, Inspection, and Repair.

(1) Clean all parts of the heater assembly with a cloth moistened with an approved cleaning solvent. Dry thoroughly.

(2) Clean the heater core (4) with compressed air.

(3) Inspect the motor assembly (8) for worn bushings or excessive end play. Replace as required. Inspect the fan (12) for cracked blades.

(4) Check the heater core (4) by applying 100-120 pounds per square inch air pressure to the core while immersing in water. If core is defective, replace.

d. Assembly. Assemble the heater in the reverse order of disassembly.

e. Installation. Install the heater in the reverse order of removal.

Section II. BODY COMPONENTS

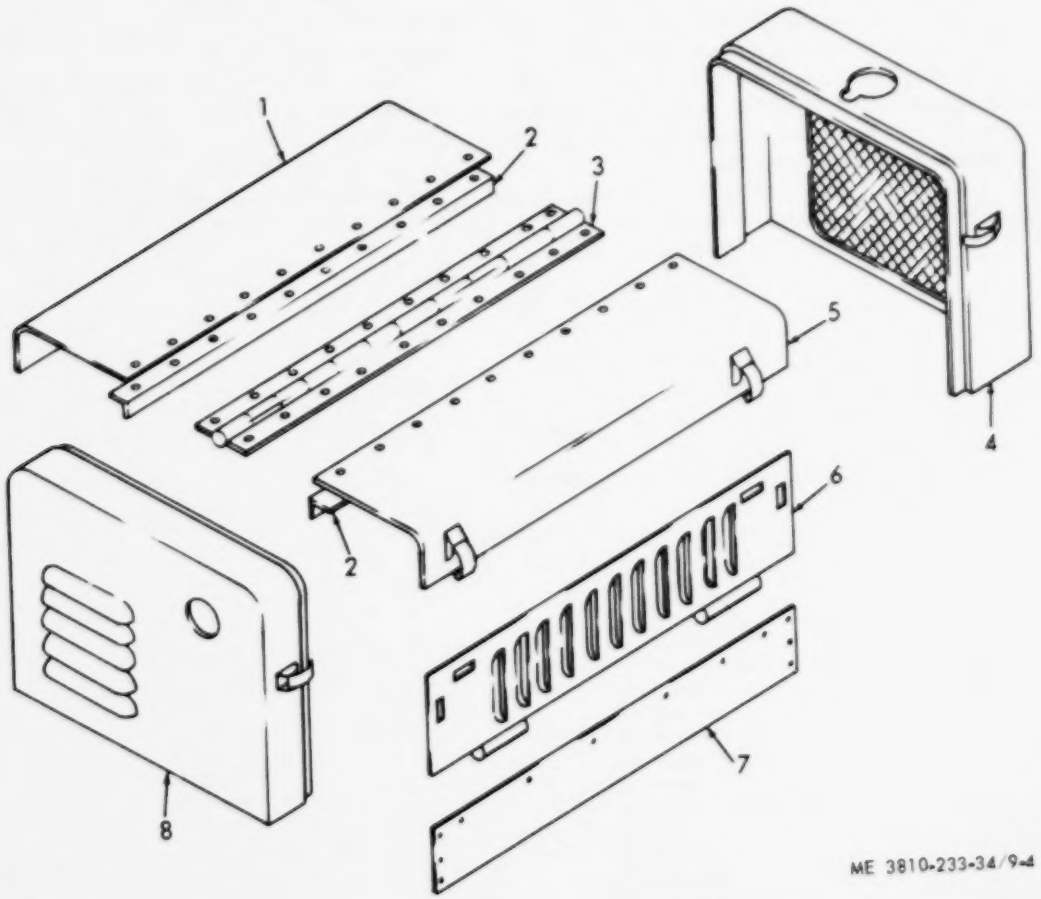
9-4. Engine Hood

a. Removal. Remove the engine hood (TM 5-3810-233-12).

b. Disassembly.

(1) Separate the top hood panels (1 and 5, fig. 9-4), hinge (3) and stiffeners (2) by removing sixteen screws, lockwashers and nuts.

(2) Remove two clamps from the front hood panel (8), the rear hood panel (4), and each of the top hood panels (1 and 5) by removing two screws, lockwashers, and nuts.



ME 3810-233-34/9-4

1 Top hood panel (LH)
2 Stiffener
3 Hinge
4 Rear hood panel
5 Top hood panel (RH)
6 Side panel
7 Panel
8 Front hood panel

Figure 9-4. Engine hood, exploded view.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Inspect the hinge and clamps for damage and proper operation. Replace as required.

(3) Inspect the hood panels for crack, dents, rusted areas and other damage. Clean the rusted area with a wire brush and repaint. Repair dents and other damage when possible. Replace a panel that is cracked or badly damaged.

d. Assembly. Assemble the engine hood in reverse order of disassembly.

e. Installation. Install the engine hood (TM 5-3810-233-12).

9-5. Fenders

a. Removal and Disassembly.

(1) *Left front fender.*

(a) Remove rear view mirror, lights and electrical lead (TM 5-3810-233-12).

(b) Remove nine screws (8, fig. 9-5), washers (16), and nuts (15) that secures the left front fender (23) to the supports (11 and 21).

(c) Remove three bolts (19), washers (20), washers (6) and nuts (3) from the bottom edge of the fender. Using a proper lifting device, lift the left front fender from the supports.

(d) Remove four screws (14) and washers (13) and remove the cover (18).

(e) Remove bolts (19), washers (6 and 20), nuts (3), and shim (22) and remove the supports (21 and 11) from the frame.

(f) Remove two screws (25), washers (27), nuts (28), and handle (26).

(2) *Left rear fender.*

(a) Remove lights and electrical leads (TM 5-3810-233-12).

(b) Remove five screws (7), washers (4), and nuts (3) that secure the left rear fender to the hood.

(c) Remove nine screws (8), washers (16), and nuts (15) that secure the rear fender (9) to the three supports (11).

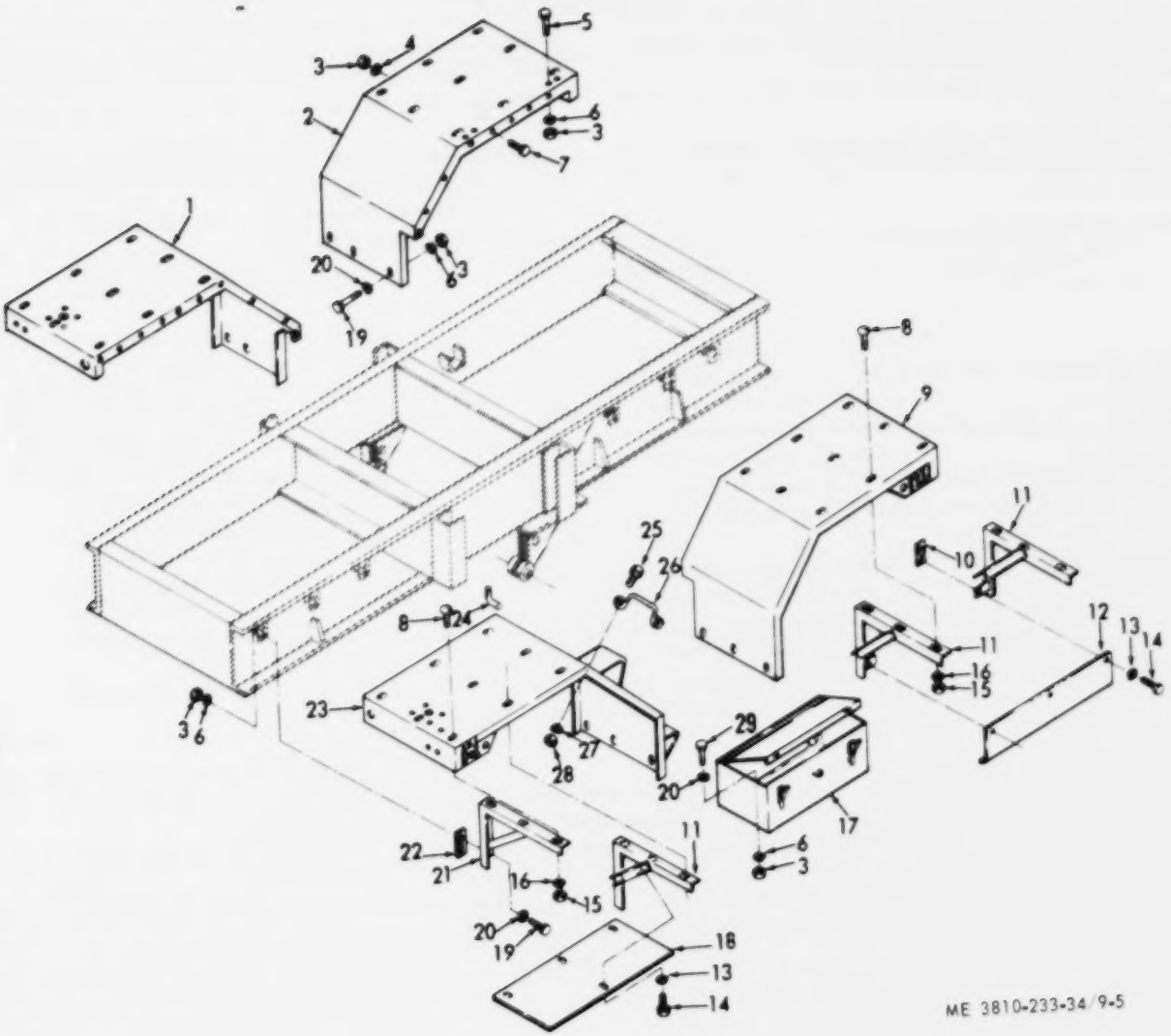
(d) Remove three bolts (19), washers (20), washers (6), and nuts (3) from the bottom edge of the fender. Using a proper lifting device, lift the rear left fender from the supports.

(e) Remove three screws (14), and washers (13) and remove the cover (12).

(f) Remove bolts (19), washers (6 and 20), nuts (3), and shims (10) and remove the three supports (11).

(3) *Right front fender.* Removal and disassembly instructions are the same as the instructins for the left front fender.

(4) *Right rear fender.* Removal and disassembly instructions are the same as the instructions for the left rear fender.



1 Fender, front, RH
2 Fender, rear, RH
3 Nut
4 Washer
5 Screw
6 Washer
7 Screw
8 Screw
9 Fender, rear, LH
10 Shim
11 Support
12 Cover
13 Washer
14 Screw
15 Nut
16 Washer
17 Tool box assy.
18 Cover
19 Bolt
20 Washer
21 Support
22 Shim
23 Fender, front, LH
24 Bar
25 Screw
26 Handle
27 Washer
28 Nut
29 Screw

Figure 9-5. Fender and mounting components, exploded view.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts with an approved cleaning solvent and dry thoroughly.

(2) Inspect all parts for cracks or broken welds. Weld cracks or broken welds where possible. Replace a badly damaged part.

(3) Remove any rusted area with a wire brush and repaint.

c. Assembly and Installation. Assemble and install the fenders in reverse order of disassembly and removal.

9-6. Outrigger Assembly

a. Removal. Remove the outrigger arms and pads (TM 5-3810-233-12).

b. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with an approved cleaning solvent and dry thoroughly.

(2) Inspect the pads, arms, and frame for broken welds, cracks, dents, and worn or rusted spots. Repair broken welds, cracks, and dents where possible. Sand worn and rusted spots and repaint.

(3) Replace badly damaged pads or arms and other badly damaged parts.

c. Installation. Install the outrigger pads and arms (TM 5-3810-233-12).

APPENDIX A

REFERENCES

A-1. Fire Protection	
TB 5-4200-200-10	Hand Portable Extinguishers Approved for Army Users
A-2. Lubrication	
C9100-IL	Identification List for Fuels, Lubricants, Oils, and Waxes
LO 5-3810-233-12	Lubrication order
A-3. Maintenance	
TM 9-1870-1	Care and Maintenance of Pneumatic Tires
TB 750-651	Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems
TM 38-750	The Army Maintenance Management Systems
TM 5-3810-233-ESC	Equipment Serviceability Criteria
TM 5-3810-233-12	Operator and Organizational Maintenance Manual
TM 5-3810-233-20P	Organizational Maintenance Repair Parts and Special Tool Lists
TM 5-3810-233-35P	Direct and General Support and Depot Maintenance Repair Parts and Special Tool Lists
TM 9-6140-200-15	Operation and Organizational, Field and Depot Maintenance: Storage Batteries, Lead Acid Type
TM 385-101	Safe Use of Cranes, Crane-Shovels, Dragline and Similar Equipment Near Electric Power Lines
A-4. Shipment and Storage	
TB 740-97-2	Preservation of USAMEC Mechanical Equipment for Shipment and Storage
TM 740-90-1	Administrative Storage of Equipment
A-5. Destruction to Prevent Enemy Use	
TM 750-244-3	Procedure for Destruction of Equipment to Prevent Enemy Use

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WARNING

CARBON MONOXIDE, A DEADLY GAS
is released in the exhaust of this equipment

DEATH
or severe illness may result if
personnel fail to observe safety precautions.
Do not operate this engine in an inclosed area for a lengthy interval unless the exhaust is piped to an open area.

EXPLOSION AND FIRE HAZARD
is present when servicing batteries
and filling fuel tanks.

DEATH
or severe injury may result if
personnel fail to observe safety precautions.
Do not smoke or use open flame around flammable materiel or when servicing the batteries or when fuel tank is being filled.
Keep fuel container and funnel in contact while tank is being filled, or provide a ground to prevent static sparks from igniting the fuel.
Do not attempt to weld a fuel tank unless the tank has been purged of all combustible vapors. Refer to TM 9-237 for safety precautions for welding containers that have held combustibles.

HIGH VOLTAGE HAZARD
is present if the boom accidently contacts a power line.

DEATH
or severe injury may result if
personnel fail to observe safety precautions.
Keep the boom away from power lines.
If the boom accidently contacts a power line, jump from the machine; do not step off.

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